JUL 10 1937

Heating · Piping and Air Conditioning

...Installation
...Maintenance
...DUSTRY AND
...BUILDINGS

...ULY, 1937

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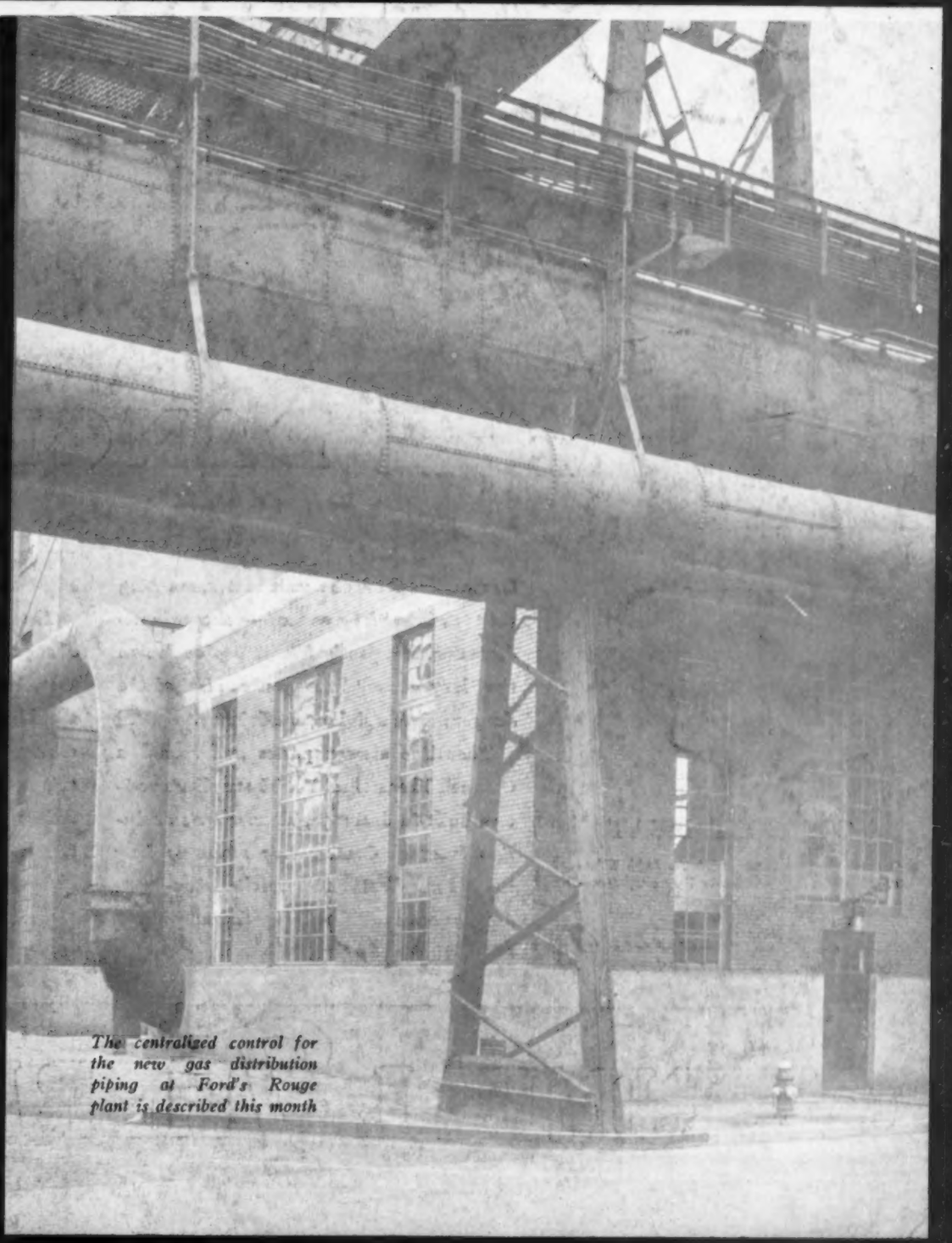
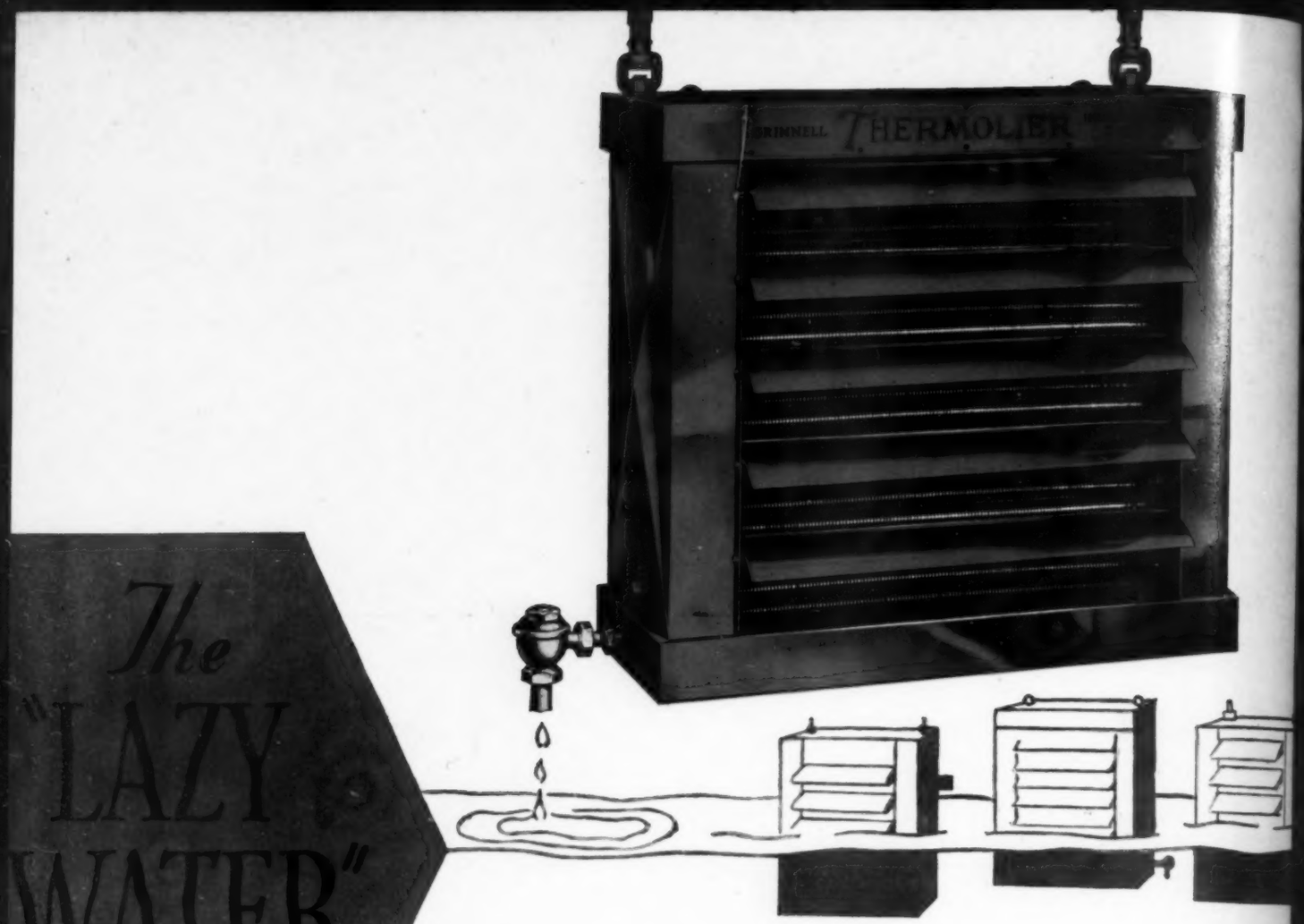
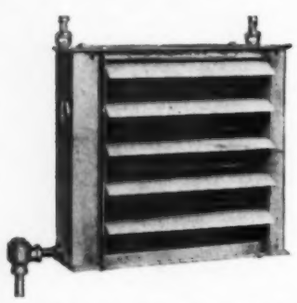


The centralized control for the new gas distribution piping at Ford's Rouge plant is described this month



The "LAZY WATER" LINE IS THE DANGER LINE!



LOW COST HEAT

Owners Report Savings Up To 28% When Thermoliers Replace Other Types Of Heating Systems.

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Shown, top of page, Thermolier Industrial Type. Above, Thermolier Factory Type.

Draw a line through a unit heater, marking the top of the "lazy water"—collected condensation that partly fills it. You've drawn the "lazy water" line—you've marked the *danger line* of unit heater efficiency.

That line always passes *underneath* a Grinnell Thermolier! For Thermolier's positive built-in drainage, Thermolier's exclusive Internal Cooling Leg mean *no lazy water can collect in a Thermolier! Continuous* removal of condensation keeps *all* of the heater working, *all* of the time.

That is only one of Thermolier's 14 points of superiority. But it's important enough that, before buying any unit heater, you should find out what provision is made for removal of "lazy water." Learn more about this better way toward better heating before cold weather comes! Write to-day for the free Thermolier Data Book. Grinnell Co., Inc., Executive offices, Providence, R. I., Branch offices in principal cities.

GRINNELL THERMOLIER

THE UNIT HEATER WITH 14 POINTS OF SUPERIORITY

The Editor's Page

■ **Air conditioning installations** in Kansas City reported up to and including the last day of May, totalled approximately 2100 hp as compared with 2200 hp for the entire year of 1936, reports "The Air Conditioner," published by the Air Conditioning Council of Kansas City. Other installations now on order or partially completed are expected to raise the figure for the year to 3300 hp. . . . New all-time records for air conditioning contracts closed in Chicago during the month of May were established this year with contracts for 88 plans, an increase of 20 per cent over the same month last year. Combined capacity of installations is 1321 hp, an increase of 94 per cent over May 1936, indicating the jobs are considerably larger in average size. . . . Restaurants headed the list with 30 installations, private offices came second with 14, and general offices and drug stores next with 9 each. . . . According to a recent issue of "Business Week," among the demands of a union recently formed in a luggage factory was air conditioning in the plant. . . . A retail clerks' union recently asked for air conditioning in stores, says the same source.

■ **With the number** of air conditioning jobs increasing by leaps and bounds (as the saying goes), good engineering and proper installation is of greater importance than ever before. . . . There are those who are quick to find fault with anything new to them; and there are installations that because of improper control, faulty air distribution, incorrect operation do not give the results that it is possible to achieve. . . . A poor job is often worse than none at all, gives a black eye to the industry. One such installation may be the subject of many "letters to the editor" which, published in the daily press, create a public opinion unfair to properly designed, installed and operated systems.

■ **We are all a lot of fish** living at the bottom of an ocean which is some 30 or 40 miles deep, Robert T. Williams, engineer, Carrier Corp., told the mechanical conference of the American Newspaper Publishers Association in a talk on air conditioning newspaper plants last month. We do our work, our machines work and our materials are constantly bathed in this ocean of air. It has weight which presses on us at all times 14 lb per sq in.; it supplies the basis for all combustion, both personal and industrial; it corrodes our materials; it is at once our principal conveyor of heat and our principal insulator. And still—until comparatively recently—we were pretty apt to neglect any consideration of it in our life of work. . . . It seems absurd, he said, to think that for years we have been carefully piping gas, electricity and water in places where they are needed, but have made our equipment forage for the air it requires.

■ **Railway tours** crisscrossing the United States in air conditioned coaches at a cost of little more than 1c per mile are the latest lure for vacationists, says William B. Henderson, executive vice-president of the Air Conditioning Manufacturers' Association. . . . Every one of the Missouri Pacific's passenger cars is air conditioned or is in the shop being equipped, it is said. "We have been well rewarded in the way of additional traffic and I doubt if anything has contributed more to the return of passenger traffic to railways than air conditioning of equipment," is the opinion of Paul J. Neff, assistant vice-president of the M. P. . . . A feature of the air conditioning of 22 deluxe cars of the French Indo-China government railways is a special heating unit using electricity for power. The heating is needed for a part of the run which goes through a mountainous section where the temperatures drop below freezing, as the cars are to be used on the 1,050 mile route between Hanoi and Saigon. . . That modernized, high speed, air conditioned passenger train service is profitable is indicated by a recent announcement of the Chicago, Milwaukee, St. Paul & Pacific Railroad. It has been determined that the net profit of the "Hiawatha," crack train between Chicago and Minneapolis-St. Paul, is $2.49 a mile.

The Consolidated Edison Company of New York pictures the unfortunate individual without an air conditioned office like this in its newspaper advertising featuring the advantages of comfort cooling.

■ **A serious shortage** of skilled labor is revealed by a survey conducted by Warner & Swasey Co., Cleveland, makers of machine tools and precision instruments. Based on a questionnaire returned by 229 concerns employing a total of 791,820 people, 195 firms said they were experiencing a shortage of skilled labor, while 34 said they were not. . . . Types of workmen chiefly needed were reported as machinists, tool makers, machine operators, lathe operators, boring mill operators, automatic screw machine operators, and moulders. . . . The Machinery and Allied Products Institute, 221 N. La Salle St., Chicago, has recently issued a bulletin and charts giving essential facts concerning durable goods activity, defining what is meant by the term and describing the characteristics of durable goods.

■ **The first formal contract** for exhibit space in a building to be constructed by the New York World's Fair 1939 has been signed by the Westinghouse Electric and Mfg. Co., Grover Whalen, president of the Fair, has announced. The contract is for 11,000 sq ft of floor space in the electrical production building. Among the displays will be featured air conditioning in all its phases, according to Westinghouse. . . . The American Gas Association has signed a contract for 122,008 sq ft of ground in the community interests zone of the Fair. The Association plans to erect a building in which will be shown exhibits on air conditioning, water heating and other gas using services. . . . Johns-Manville will erect a Fair building in which will be featured advances in building materials.

■ **The mortician** should remember when installing air conditioning equipment that it is going to be a permanent fixture, required to perform its duties year in and year out, cautions S. F. Myers, Westinghouse air conditioning sales manager. It is the initial cost plus the operating cost the year around and over a period of years that determines the cost of air conditioning, Mr. Myers points out. . . . An example of the inexpensiveness of air conditioning quoted by Mr. Myers is the case of a funeral home in Miami, Florida where

[*Continued on p. 134, back section*]

LIMITED WATER SUPPLY NO OBSTACLE

Carrier
Air Conditioning

NOTE: Erected in 1913, the Leader Building in Cleveland, Ohio is typical of many office buildings throughout the United States where the water supply is limited because of small mains. How Carrier year around Air Conditioning was provided for the 13th and 14th floors of this building without enlarging existing water mains or extensive remodeling, is of interest to every architect, engineer, building owner or manager.

What is YOUR Air Conditioning Problem?

MAKING it possible to secure the benefits of year 'round air conditioning where water rates are high or the supply is inadequate, is but one of Carrier's many achievements. For more than 35 years, Carrier has devoted its efforts exclusively to solving such problems, including the invention of true air conditioning and to making economical, dependable air conditioning for every enclosure regardless of size or location.

• To refine the art, Carrier developed such features as the By-Pass, Dew Point Control and Zoned Control. And when refrigeration needs outgrew existing equipment, Carrier broke away from traditional design to develop Centrifugal Refrigeration. Carrier installations in 99 countries of the world—ranging in size from one room to such famous structures as the U. S. Capitol, Macy's, Radio City, Palmer House and Los Angeles Times, bear witness to Carrier's technique.

• Whatever your air conditioning problem—you'll find Carrier well qualified to help you. Your local Carrier representative can show you many tested time-and-money savers. And show you how, by acting at once, you can still secure the benefits of Carrier Air Conditioning for this summer's use.

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850 Frelinghuysen Avenue, Newark, N. J.
Please send me your latest Catalog in Sweet's—and name of the nearest Carrier Representative.
Name.....
Company.....
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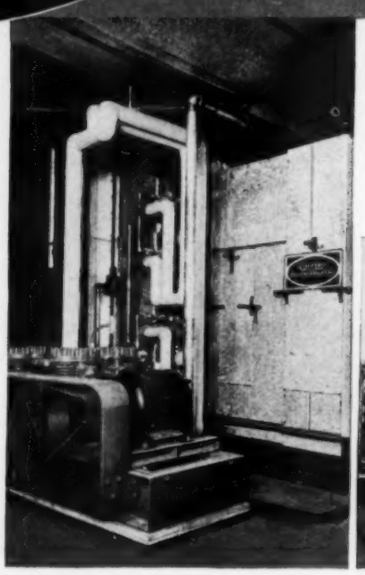
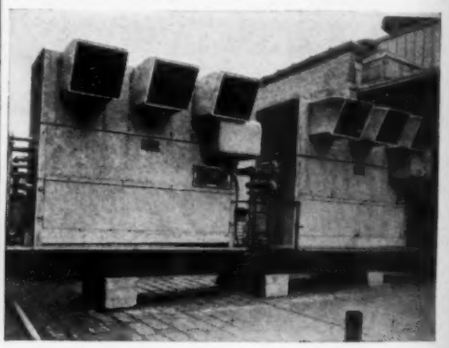


ZONED CONTROL for the 13th and 14th floors was made possible by Carrier Dehumidifiers and Refrigeration machines like these, located on the upper floors. But in place of the usual water towers, spray decks or water condensers—any of which would require enlarging of water mains throughout the building . . .



. . . **CARRIER EVAPORATIVE CONDENSERS** (see illustration directly above) were located on the roof. Using less than 5% of the water required by water condensers or other types of water equipment, these efficient condensers solved the Leader Building's problem completely, without enlarging water mains or extensive alterations of any kind.

CONCEALED DUCTWORK is another unusual feature of the Carrier installation in this 24 year old building. In this office, for example, ductwork is concealed by a slightly lowered, false ceiling, while a pan type outlet diffuses the conditioned air. This same ductwork leads to an adjoining . . .

. . . **EXECUTIVE OFFICE,** where the Carrier outlet is in the wall, over the door. Compare the two offices—notice that ceiling height has not been sacrificed by this inexpensive, efficient method of remodeling the Leader Building.

Heating·Piping and Air Conditioning

with which is merged the "Aerologist"

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Operation, Maintenance
in Industry and Large Buildings

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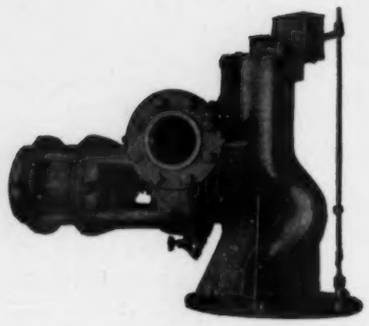

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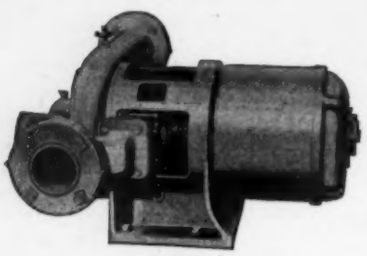

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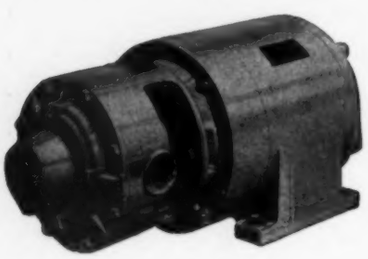
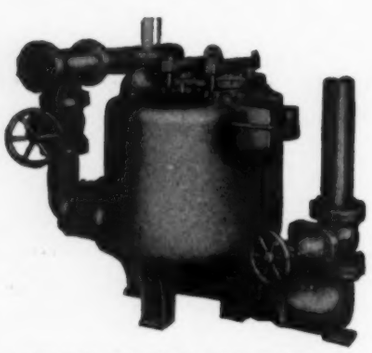
STANDARD AND SELF-PRIMING

Motor armature and pump impeller mounted on same shaft. No bearings in pump casing. One stuffing box. Simple, compact, reliable.



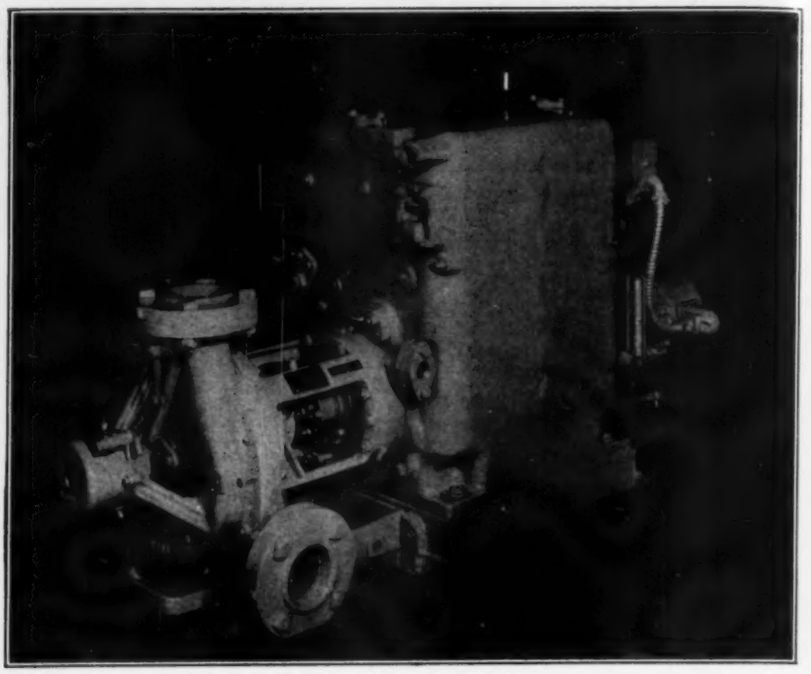
NASH HYTOR AIR COMPRESSORS

No sliding vanes, pistons nor parts in metallic contact. No internal lubrication. Non-pulsating. Clean air. Efficient and reliable.



JENNINGS SEWAGE EJECTOR

Most efficient device for pumping unscreened sewage from low levels, or pumping any heavy liquid with large proportions of solids.



Jennings Vapor Turbine Heating Pump. Operates directly from system steam without electric current. Constant operation assures uniform system operation. Steam used for operation is returned to system for heating with little heat loss. Eliminates current cost and effects material steam economy. Ask for Bulletin 246-A.

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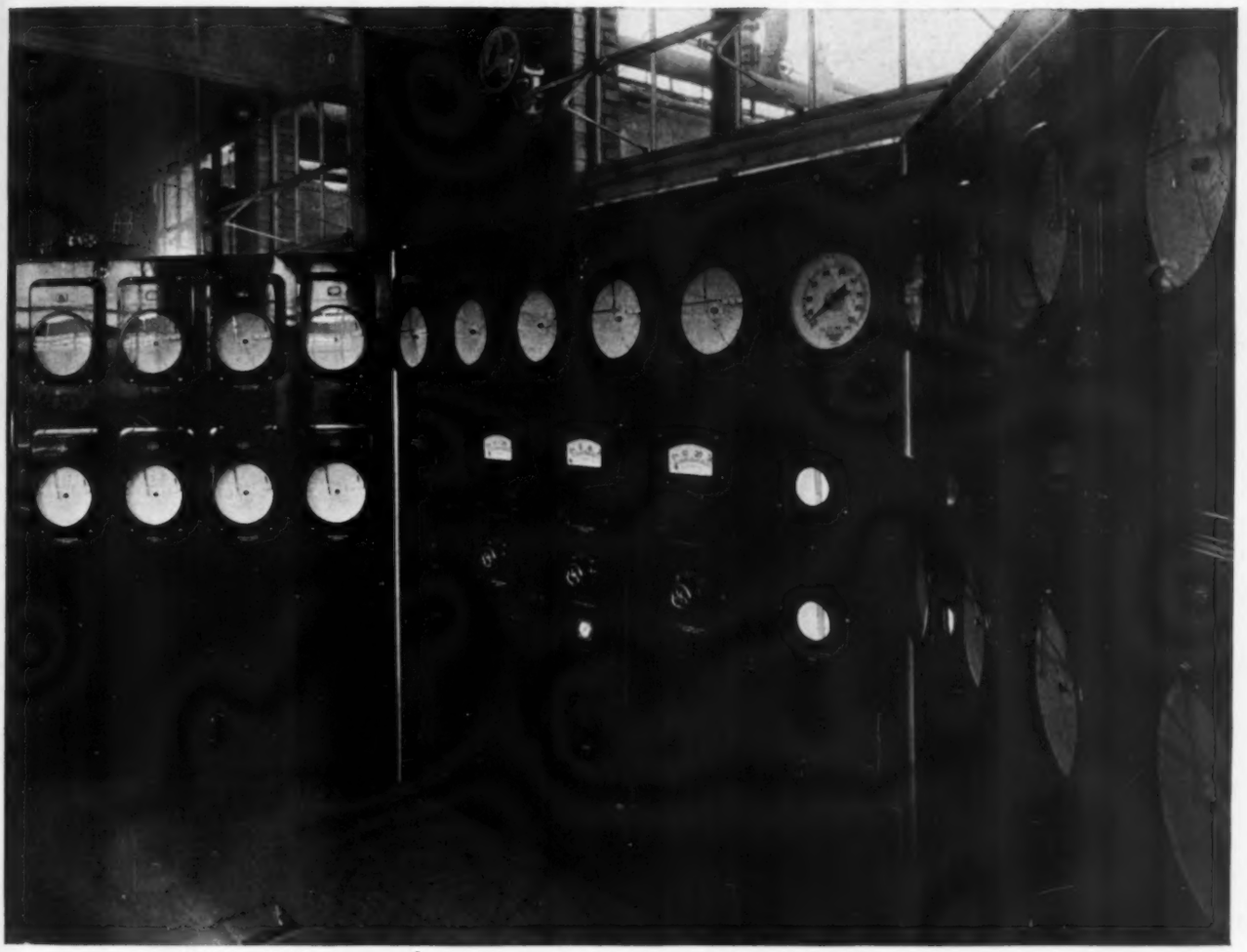
Vol. 9, No. 7 ● *July, 1937*

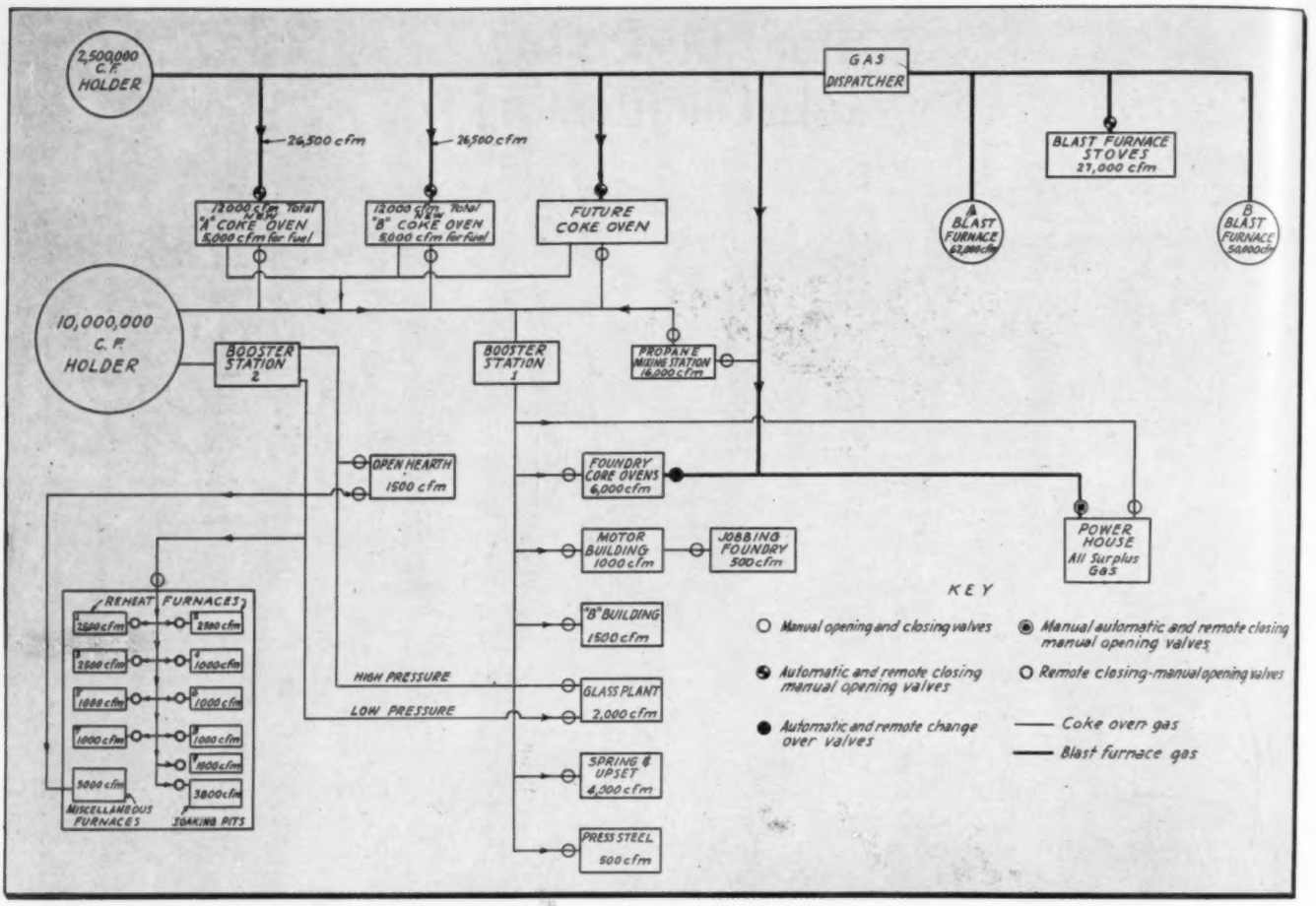


These instruments enable centralized control of the gas piping system

Ford Centralizes Control of New Gas Distribution Piping

PIPING is industry's most important and widely used transportation system, and—like any other transportation system—its efficient use requires carefully planned methods of control of the materials conveyed. Recent developments have made it possible to dispatch and govern fluids in piping systems from a central point with the same or greater celerity than that which characterizes the control of a railroad system or an electrical distribution system.

An outstanding example of what can be accomplished in the supervision and control of industrial piping services is the elaborate electrically operated supervisory control system for the new gas distribution system which is soon to be completed at the Rouge plant of the Ford Motor Co. at Dearborn, Mich. Believed to be the first application of such a control unit to an industrial gas system, the method will provide automatic and remote control of all gas consumption points throughout the plant by a single, centrally situated dispatcher. Properly to control an extensive piping system requires that the dispatcher have detailed knowledge of conditions at various points in the piping,



Main gas consuming units and control valves at the Rouge plant

and provisions for remote reading of such conditions are therefore incorporated in the design of the supervisory control.

The New Gas Distribution System

The new gas distribution system became necessary because of increasing use of gas in the reheat furnaces, conversion of electric and oil furnaces to gas firing, and provision for future expansion in the use of gas. Included in the project has been the construction of a new 10,000,000 cu ft coke oven gas holder and a 2,500,000 cu ft blast furnace gas holder to serve as temporary storage centers, storing gas produced during lighter periods of plant activity and releasing it for use during periods of heavier activity; installation of a butane-propane gas mixing station; and improvement and enlargement of the gas pipe lines because the old system was inadequate for carrying the volumes efficiently at desired pressures. Coupled with the piping improvements is a $4,000,000 coke ovens expansion program which increases by some 8,000,000 cu ft a day the output of gas for general plant use. The plant's gas compressor capacity is being increased from 36,000,000 to 56,000,000 cu ft a day.

The quantities of gas required during an average day at the Rouge plant (in addition to coal, oil, and coal tar which are also used for fuel) were summarized by F. J. Harlow in a paper presented at the annual convention of the *Association of Iron and Steel Engineers* last fall, and published in the May, 1937, issue of the journal of the association, the *Iron and Steel Engineer*. These quantities are: 500 Btu coke oven gas, 54,000,000 cu ft; 100 Btu blast furnace gas, 560,480,000 cu ft; and 3200 Btu butane gas, 640,000 cu ft. These represent a total of over 90,000,000 cu ft of equivalent 500 Btu gas.

The 500 Btu coke oven gas is taken as the standard base, and the other available gases are blended to augment this coke oven gas supply. The fuel requirements of the various departments and the method of quality control of the gas supply were also described in Mr. Harlow's paper.

The gas is to be distributed at two pressures, with slightly over 50 per cent at the lower pressure. Gas comes from several sources, about 112,000 cu ft per minute being produced by the blast furnaces, 53,000 cu ft per minute by the coke ovens, and 16,000 cu ft per minute by the butane-propane plant, this latter gas being mixed with either air or blast furnace gas.

Plant operations will require 6,600,000 cu ft of gas a day from the holders, and the supply will be replenished with 4,600,000 cu ft of gas during the midnight shift, throughout which the coke ovens steadily produce gas which is not immediately needed for production. This results in a net daily drain of 2,000,000 cu ft or a total drain of 10,000,000 cu ft during the work week. Thus, the holder will be emptied by each Friday night and replenished by each Monday morning.

The propane mixing station will be called upon to meet peak loads and will serve as a standby supply.

This gas is mixed with blast furnace gas with a heat value of 100 Btu at a one to five ratio, resulting in a gas with a heat value of about 500 Btu. The propane mixing station houses vaporizers which change the liquefied hydrocarbon to the gaseous form, a machine for mixing propane gas and blast furnace gas or for mixing propane gas and air, when blast furnace gas is not available.

Centralized Control Essential

Wide variations in gas requirements are unavoidable in a plant the magnitude of the Rouge plant, the demand varying with the production of cars, and the supply with the coke requirements of the blast furnaces and foundry and with the seasonal consumption of domestic coke. The large amount of gas used, together with wide variations of volumes at the various gas using units, necessitates means of curtailing gas volumes to certain units and increasing volumes to other units. A "preferred" list of units has therefore been set up, the selection of which has depended upon several factors, among which the possibility of using supplementary fuels other than gas is the most important. The main gas consuming units are indicated in the distribution and control diagram shown here.

Thus, the gas comes from various sources and is distributed to many points of use throughout the plant. The imperative need for centralized control of the distribution piping system can be appreciated when it is realized that there are many variations both on the supply and the consuming ends. Under these conditions, with constant and often precipitant changes in unit volumes, proper gas distribution without central control would be haphazard and hopeless. Gas supply must be assured for jobs which are not convertible to use some other fuel. Centralized control enables flexibility and simplicity in distributing the gas to best advantage. It permits building up a gas surplus for use at peak loads. It insures safety of gas usage at all times.

Gas volumes and distribution of the gas are controlled from the central dispatch station, the dispatcher having supervision of the allotment of the various fuels to the gas consuming departments—based on the current availability of the gas—according to their relative importance. One of the illustrations shows the dispatch station with the panel board on which are the flow meters, low level indicators for holders, pressure gages, tachometers, etc. In front of this panel board is the control table on which are the switch buttons for remote control and regulation. A typical control unit on this desk consists of four colored signal lights, signal key, control key, and telephone.

How Control System Operates

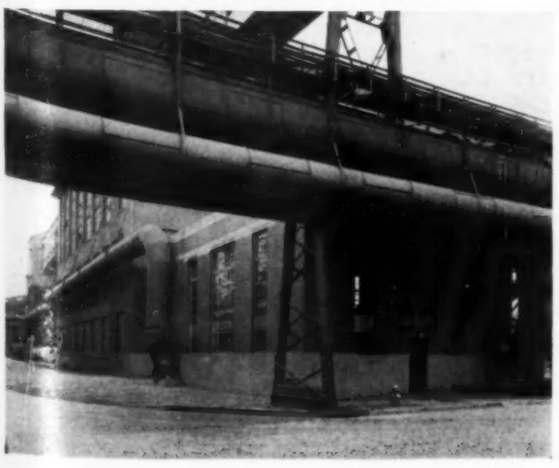
The control valves are remote closing—manual opening; their locations are indicated on the diagrammatic drawing of the distribution system. From his central control room, the dispatcher can close any master valve and lock it closed. He can unlock it so it can be opened, but the valve must be manually opened for reasons of safety. The signal lights show conditions at each valve station and permit communication between the dispatcher and the valve stations. The dispatcher also has remote control circuits for the booster pumps and fans.

Thus, the dispatcher has a picture before him of conditions throughout the distribution system, including flows, pressures, the valves that are closed or open, and the controls to change or modify the distribution as circumstances demand. He can shut off the flow at any of the remote operated valves, locking the valve shut until he releases it, or can unlock the valve so that it can be manually opened.

The piping system in the propane-blast furnace gas mixing machine is equipped to achieve the desired volumetric mixing with the pressure regulators operating butterfly valves under calorimeter control. For mixing air and propane gas, there are two displacement pumps connected by a fixed drive shaft, one for sending air into the mixture, the other for propane gas. Ford engineers have made the mechanism proof against production of an explosive mixture of propane gas and air by setting it up to be driven by the propane gas under pressure. Such mixers ordinarily are driven by motors, and unsafe mixtures may result when the operation is not regulated by the flow of the gas.

(*Concluded on page* 417)

Thousands of feet of piping convey gas throughout the Ford plant



Believed to be the first application of complete supervisory control to an industrial fuel gas distribution system, the dispatching system being installed at the Ford Motor Company's Rouge plant provides for the allotment of the fuel to the various gas using departments based on their relative importance and the availability of supplementary fuels, and on the supply . . . By means of flow meters, pressure gages, and other instruments, the dispatcher has accurate knowledge of conditions throughout the piping system, and can regulate flows according to circumstances with remote closing, manually opening valves . . . Because both the gas supply and consumption vary widely from time to time, and because of the great extent of the system, its operation without such a control scheme would be haphazard, hopeless

E. Vernon Hill* Comments . . . .

WHY do we humans do things so clumsily and inefficiently long after we have learned the fundamental truths and should be able to adopt better methods? The electrical wizard, Charles Proteus Steinmetz, once remarked "Allow ten years for the acceptance of a new idea by the public, then as a factor of safety square it."

The engineer muddles along year after year, hampered by old ideas and methods, which he well knows should be discarded. For example, we talk and think in terms of cubic feet of air instead of pounds of air, as we should. The physiologist years ago set a standard of from 25 to 30 cubic feet of outside air per minute per occupant. Legal requirements are in general still based on 25 cubic feet per person. It follows, of course, that in a theater seating 1500 people we multiply by 25 to obtain 37,500, the air supply required in cubic feet. Then when we start to calculate the cooling load we must immediately convert our cubic feet into pounds, for volumetric measurements are a variable and indeterminate thing and in thermal calculations we must have something definite with which to deal, regardless of the temperature. So we convert cubic feet into pounds.

Think of the time that could be saved if we would think in pounds instead of cubic feet. It would be much simpler, it would eliminate a lot of unnecessary calculation, and would result in a considerable saving in effort.

Taking the average weight of air as 0.075 pounds per cubic foot we find that 25 cubic feet per minute is 1.875 or approximately two pounds. Yaglou and his associates have set the minimum outdoor air supply at from 7 to 16 cfm per person; 13½ cubic feet would be one pound. Why should we not therefore select one pound of air per occupant per minute as our minimum air requirement, and two pounds as the maximum or ideal or whatever we wish to call it. It would be so much easier to remember and we would not be compelled continuously to convert cubic feet into pounds and pounds into cubic feet, as we do now in our cooling calculations.

I suggest the engineering profession begin to think in pounds of air instead of cubic feet, thereby saving much valuable time and effort. Manufacturers of fans, unit heaters, and unit coolers, and other apparatus handling air, should be perfectly willing to rate their products in pounds instead of cubic feet.

Members of city councils and legislators should be urged to use the *weight* of air instead of the *volume* in framing all new legislation dealing with this subject.

RELATIVE HUMIDITY is another term which must be classed at this time as "impedimenta." Many years ago, when the industry was young, we thought that psychrometric charts were made for the sole purpose of finding the relative humidity of the air and the dew point temperature. But as the years passed and we absorbed more of the thermodynamics of air we learned that relative humidity is not one of the factors essential in the solution of psychrometric problems. It is a term having no particular meaning or utility.

A relative humidity of 60 per cent at a dry bulb temperature of 70 F has not the same value physiologically, thermally, or in any other way as the relative humidity at 80 or 90 F dry bulb.

Relative humidity is used and talked about quite generally by the laity who *think* they understand it, but to the engineer it has little meaning or usefulness. We think and calculate in terms of dry bulb temperature, wet bulb temperature, and the temperature of the dew point, and any two of these functions serve to fix a point on the psychrometric chart.

It is wasteful of time and confusing to say a dry bulb of 80 F and a relative humidity of 50 per cent, "that is a wet bulb of 67." If we were to delete all reference to the relative humidity and speak only in terms of dry bulb and wet bulb we would have omitted nothing of value.

I suggest therefore the erasure of relative humidity lines on the psychrometric chart, or most all of them at least. Who will second the motion?

AND IN CONCLUDING our page of comments we take a farewell fling at a term that still has friends. Ventilation is becoming—has become—obsolete and we hasten it joyfully to oblivion.

Ventilation means to "blow through or blow into" a room or a building. It was a powerful word, pregnant with meaning, years ago when air conditioning was still a creeping infant; when about all we did to make indoors more habitable was to blow air into or through the building; but fortunately we move forward with time. We have learned that the gorgeous quantities of outdoor air demanded by the old regime are unnecessary, even undesirable. We no longer think that the supreme test of excellence is the full number of cubic feet of air specified. We think of *quality* rather than *quantity*, of results in comfort and health rather than a fetish, and so we, with the public, accept air conditioning and lay ventilating away with a smile and a tear. It recalls pleasant memories of the past—like "giddap" and "whoa"—but its usefulness is ended.

Yes, air conditioning is the accepted term. Its tempo fits the times, and ventilation is obsolete—and yet it makes us wonder, when we see in the advertising section of today's newspapers a picture and an alluring description of the latest gadget to invade our field—the air conditioned *pie tin*.

*Member of Board of Consulting and Contributing Editors.

Practical Standards for Air Conditioning Calculations

Psychrometric Charts

By W. S. Bodinus*

THE psychrometric chart developed by Willis H. Carrier for ordinary atmospheric air temperatures is reproduced on the next page. The use of such charts is indispensable in analyzing changing air conditions which can be graphically pictured very quickly. After the conditions are once established, tables such as those printed in the *A.S.H.V.E. Guide* (and to be published with a future installment of this series) should be used.

In order to familiarize the engineer with the use of these charts, the following examples and information are given. All references to temperatures are in degrees Fahrenheit.

Dry bulb temperatures are represented by vertical lines with values indicated on lower edge of chart.[1]

Wet bulb temperatures are represented by oblique lines with values indicated at their intersections with the curved line marked "Dew Point or Saturation Temperatures."

Dew point temperatures are represented by horizontal lines with values indicated at their intersections with the curved line marked "Dew Point or Saturation Temperatures."

Percentages of relative humidity are represented by converging curved lines with values indicated thereon.

Any two of the above properties may be found if the other two are known. The following examples indicate the methods of using the chart. It should be noted that in the case of saturated air, the dry bulb, wet bulb and dew point temperatures are identical.

Example 1—Given: Dry bulb temperature, 70 F; wet bulb temperature, 60 F. Find the percentage of relative humidity and the dew point.

Locate point of intersection of vertical line representing 70 F dry bulb temperature with the oblique line representing 60 wet bulb temperature. By interpolation, this point indicates the percentage of relative humidity as 56 per cent and by following the intersecting horizontal line to the left to its intersection with Curve *A* the dew point is indicated as 53.4 F.

Example 2—Given: Dry bulb temperature, 80 F; relative humidity, 59 per cent. Find the dew point and wet bulb temperatures.

Locate the point of intersection of the vertical line representing 80 F dry bulb temperature with the interpolated position of the curved line which would represent 59 per cent relative humidity. Reading horizontally to the left from this point to Curve *A* the dew point is indicated as 64 F, and reading obliquely upward to the left, between the wet bulb lines, to Curve *A*, the wet bulb temperature is indicated as 69.3 F.

Example 3—Given: Dry bulb temperature, 75 F; dew point temperature, 55 F. Find percentage of relative humidity and wet bulb temperature.

Locate the point of intersection of the vertical line representing 75 F dry bulb temperature with the horizontal dew point line intersecting Curve *A* at 55 F. By interpolation, this point indicates the relative humidity as 50 per cent and the wet bulb temperature as 62.6 F.

Example 4—Given: Relative humidity, 50 per cent; wet bulb temperature, 60 F. Find dry bulb temperature and dew point.

Locate the point of intersection of the curved line representing 50 per cent relative humidity with the oblique line representing 60 F wet bulb temperature. Reading vertically downward from this point to the dry bulb temperature scale, the dry bulb temperature is indicated as 71.7 F, and reading horizontally to the left to Curve *A*, the dew point is indicated as 52 F.

Example 5—Given: Wet bulb temperature, 55 F; dew point, 50 F. Find dry bulb temperature and relative humidity.

Locate the point of intersection of the oblique line representing 55 F wet bulb temperature with the horizontal line representing the dew point of 50 F. Reading vertically downward from this point to the dry bulb temperature scale, the dry bulb temperature is indicated as 61.5 F, and by interpolation the relative humidity is indicated as 67 per cent.

Example 6—Given: Relative humidity, 40 per cent; dew point, 40 F. Find dry bulb temperature and wet bulb temperature.

Locate the point of intersection of the curved line representing 40 per cent relative humidity with the horizontal line intersecting Curve *A* at 40 F dew point temperature. Reading vertically downward from this point to the dry bulb temperature scale, the dry bulb temperature is indicated as 65 F, and reading obliquely upward to the left, along the wet bulb lines to Curve *A*, the wet bulb temperature is indicated as 52 F.

Total Heat of Air

The total heat of air is composed of the sensible heat, or heat due to the temperature of the air as indicated by the ordinary thermometer, and the latent heat, or heat of vaporization of the moisture or vapor in the air. The total heat is a constant quantity for any given wet bulb temperature, irrespective of any change in the dry bulb temperature. This fact has been termed by Carrier[2] "One of the four fundamental psychrometric principles."

In the psychrometric chart, the total heat is shown for the sake of convenience as above zero degree Fahrenheit. Furthermore, total heat, as here used, does not include the sensible heat of the liquid nor the latent heat of fusion. It is assumed that the water evaporated is initially at the wet bulb temperature.[3]

To find the total heat, the wet bulb temperature must be known. Find the point on Curve *A* which corresponds

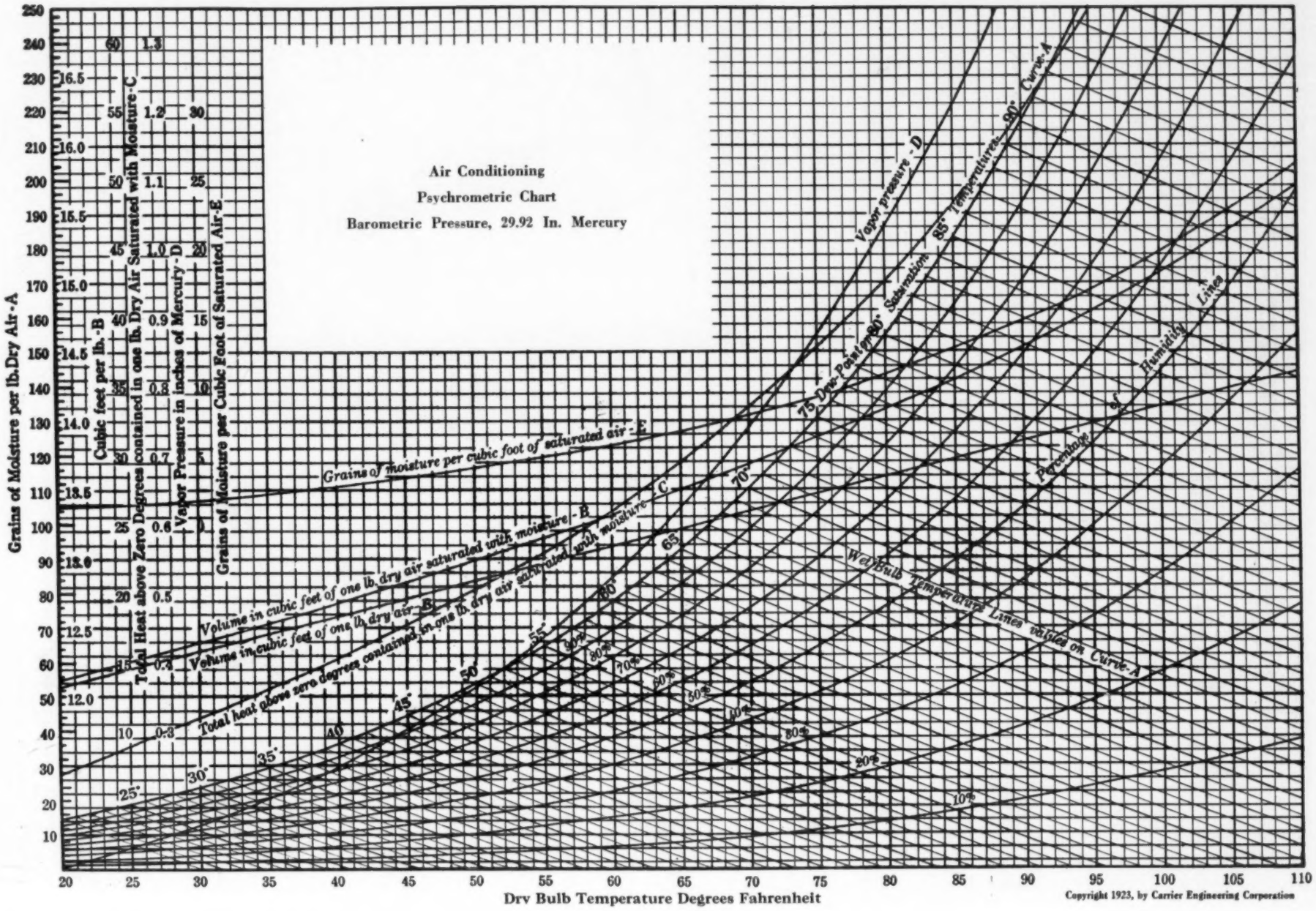
*Engineer, Carrier Corp.

Part 3 of a series. Part 1 was published in the May issue, pp. 281-284, and Part 2 in June, pp. 367-368.

[1]See Part 1 for definition of terms.

[2]"Rational Psychrometric Formulae," *Transactions, A.S.M.E.*, 1911, Vol. 33, p. 1005.

[3]"Temperatures of Evaporation," Carrier and Lindsay, *Transactions, A.S.M.E.*, 1925, Vol. 46, Append. No. 1, p. 763.


Air Conditioning
Psychrometric Chart
Barometric Pressure, 29.92 In. Mercury
Grains of Moisture per lb. Dry Air - A
Grains of Moisture per Cubic Foot of Saturated Air - E
Cubic feet per lb. - B
Total Heat above Zero Degrees contained in one lb. Dry Air Saturated with Moisture - C
Vapor Pressure in inches of Mercury - D
Vapor pressure - D
Saturation - 85° Temperatures - 90° Curve - A
75° Dew Point - 60°
Humidity Lines
Percentage of
Grains of moisture per cubic foot of saturated air - E
Volume in cubic feet of one lb. dry air saturated with moisture - B
Volume in cubic feet of one lb. dry air - B
Total heat above zero degrees contained in one lb. dry air saturated with moisture - C
Wet Bulb Temperature Lines taken on Curve - A
Drv Bulb Temperature Degrees Fahrenheit

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to the given wet bulb temperature. Read vertically (upward or downward) to Curve *C*, "Total Heat above Zero Degrees Contained in One Pound Dry Air Saturated with Moisture." Then read horizontally to the left to Scale *C*.

Example 7—Having air at a wet bulb temperature of 70 F and air at a wet bulb temperature of 61 F, find the difference in total heat between a mixture containing one pound of dry air and the quantity of moisture present at the wet bulb temperature of 70 F; and a mixture containing one pound of dry air and the quantity of moisture present at the wet bulb temperature of 61 F.

The quantity of moisture present at any given wet bulb temperature will, of course, vary with the existing dry bulb temperature. Since the total heat is a function of the wet bulb temperature, irrespective of the dry bulb temperature, the quantity of moisture present does not affect the total heat so long as the wet bulb temperature does not change.

Note that the chart deals with a mixture containing one pound of dry air *plus* the amount of moisture present under the given conditions. In no instance does the chart contemplate a pound of mixture (air and moisture together), but always a mixture containing one pound of dry air.

Find the point on the wet bulb temperature scale corresponding to 70 F. Read vertically upward to Curve *C*. From this intersection read horizontally to the left to scale *C*, which indicates the total heat (above 0 F) as 33.5 Btu. Repeat this procedure to ascertain the total heat at the wet bulb temperature of 61 F, which is indicated as 26.7 Btu. Then, subtracting, 33.5 — 26.7 = 6.8 Btu, which is the difference in total heat.

This procedure is used in engineering calculations to ascertain the heat to be removed in cooling from one condition to another.

Change in Relative Humidity

To find the resulting relative humidity when heating or cooling air without changing its dew point:

Find the dew point for the given conditions, which is the horizontal line through the point of intersection of the vertical dry bulb line with the oblique wet bulb line. Follow this line horizontally to the new dry bulb temperature line and read the percentage of relative humidity for this point of intersection.

Example 8—Given: Dew point, 70 F, and dry bulb, 80 F. Find the relative humidity if the dry bulb temperature is increased to 90 F, the dew point temperature remaining constant.

Locate intersection of the vertical 80 F dry bulb line with the horizontal 70 F dew point line. From this point read horizontally to the right to the vertical 90 F dry bulb line and at this intersection interpolate for the percentage of relative humidity, which is indicated as 52 per cent.

Example 9—Given: Dry bulb temperature, 70 F; wet bulb temperature, 60 F. Find the resulting relative humidity when air is heated to 80 F (dry bulb temperature).

The point of intersection of the vertical 70 F dry bulb and oblique 60 F wet bulb lines indicates an existing humidity of 56 per cent. Reading horizontally to the right from this point to the intersection with the vertical 80 F dry bulb line the resulting relative humidity is indicated as 40 per cent.

Vapor Pressure and Absolute Humidity

Vapor pressure (in inches of mercury) depends upon the dew point and is represented by horizontal lines with values indicated on Scale *D*. To determine the vapor pressure, read horizontally from the intersection of the vertical dry bulb line with the oblique wet bulb line, to Curve *A* and vertically to the intersection with the "Vapor Pressure" curve (*D*); then horizontally to the left to Scale *D*.

Example 10—Given: Dry bulb temperature, 80 F; wet bulb temperature, 70 F. Find the vapor pressure.

Find the point of intersection of the vertical 80 F dry bulb line with the oblique 70 F wet bulb line. From this point read horizontally, to the left, to Curve *A*. (Dew point is indicated on this scale as 65.5 F). From this second point read vertically to Curve *D*. From the vertical intersection with Curve *D*, read horizontally to the left to Scale *D*, where the vapor pressure is indicated as 0.63 in. of mercury.

Absolute humidity is a function of the dew point and may be expressed either in grains per pound of dry air in the mixture, or in grains per cubic foot.

The grains of moisture per pound of dry air in the mixture are represented by horizontal lines with values indicated on Scale *A*, "Grains of Moisture Per Pound of Dry Air." To find the grains of moisture per cubic foot for air under given conditions, first determine the grains per pound of dry air in the mixture, by finding the intersection of the vertical dry bulb line with the oblique wet bulb line and reading from there horizontally to the left to Scale *A*, "Grains of Moisture Per Pound of Dry Air."

The volume in cubic feet per pound of dry air is represented by horizontal lines with values indicated on Scale *B*, "Cubic Feet Per Pound." Find the points of intersection of the vertical dry bulb temperature line with the curves *B*, "Volume in Cubic Feet of One Pound of Dry Air Saturated with Moisture" and "Volume in Cubic Feet of One Pound of Dry Air." From these points read horizontally to the left to Scale *B*, where the values are shown. The difference in the two volumes is the increased volume of the mixture, due to the presence of the moisture at 100 per cent relative humidity.

To determine the volume of an unsaturated mixture, multiply the difference between the two *B* curves by the per cent relative humidity. Add this result to the volume of one pound of dry air at the same temperature. Then the grains of moisture per cubic foot of this mixture, *i. e.*, the absolute humidity, is the grains of moisture per pound of air, as determined for the given conditions on Scale *A*, divided by the volume which has been determined for one pound of the mixture.

Note—For actual use a chart of larger size than that on page 416, with cross-section lines printed in color, is more convenient.

[*To be continued*]

[*Concluded from page* 413]

Gas is conveyed from the blast furnace department by a new 5 ft main about 600 ft long. Its pressure is raised at the booster station. Thousands of feet of new pipe are required to carry coke oven gas to various plant departments. One branch alone, that to the steel mills, is nearly a mile long.

The gas holder and the new high and low pressure centrifugal compressors are being built at a point near the south end of the Rouge open hearth furnace department. Gas will be conveyed to the compressor and holder from the coke ovens, on the east side of the Rouge River slip which juts northward into the plant grounds, through a 13 ft tunnel several hundred feet long which will be located beneath the slip.

Pumping Head on Air Conditioning Systems Reduced by Using Siphon

By **William Goodman***

AIR conditioning equipment requiring water must frequently be situated on an upper story of a building; for example, air cooling coils often are, and condensers sometimes are, placed on the top floor or the roof. If the water required for this equipment is obtained from either a city main or a deep well, it must be conducted back to a lower level to be wasted into the city sewers, as illustrated in Fig. 1. If the water comes from an ice tank, it must also be conducted back to a lower level to be returned to the ice tank.

Under these circumstances, the possibility of substantially reducing the pumping head, or even sometimes of eliminating an otherwise needed pump, is often overlooked. This can be accomplished by utilizing the flow of water down the vertical discharge pipe to maintain a vacuum at the outlet of the elevated equipment. The maintenance of vacuums at the high point of piping systems by the flow of water down vertical pipes is not new, the most common example being the water siphon described in most elementary physics texts and used in waterworks practice. It is the purpose of this article to call attention to the possibilities of utilizing these vertical discharge pipes; to discuss the underlying theory; and to mention a few practical pointers.

*The Trane Co. Member of Board of Consulting and Contributing Editors. Copyright, 1937, by William Goodman.
Part 1. Part 2 will appear next month.

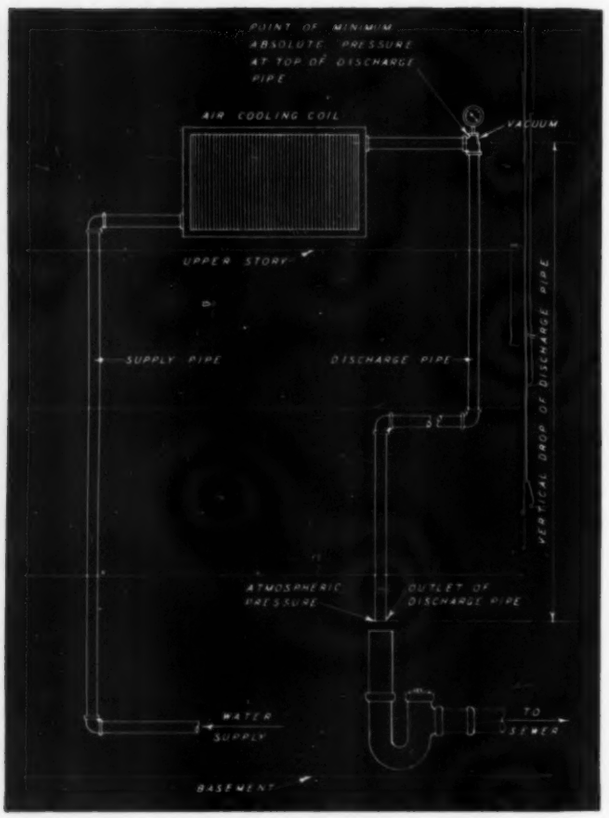


Fig. 1—Where air conditioning equipment using water from city mains or a deep well must be situated on an upper floor of a building—as illustrated—the water must be conducted back to a lower level to waste it to the sewer. By proper design the energy of the falling water may be used to reduce the head on the pump and thereby effect important installation and operating economies

Reduction in Head on Pump

In all vertical pipe lines of water, the pressure falls off one pound per square inch for each 2.3 feet of vertical rise. This is true whether the water is flowing down the pipe or not.[1] The water issuing from the outlet at the bottom of the discharge pipe of Fig. 1 is at atmospheric pressure, which is 14.7 lb per sq in. absolute. This being the case, it is evident that at a point 34 ft (14.7×2.3) above the outlet of the discharge pipe, the pressure will be zero absolute, or, in other words, a vacuum of 30 in. of mercury. *If a sufficient vertical drop can be obtained for the discharge pipe,* it is possible to maintain a pressure considerably below atmospheric on the outlet side of the air conditioning equipment, which must, because of other considerations, be installed on an upper story of a building.

Now in order to understand why the sub-atmospheric pressure on the outlet side of the equipment is desirable, it is important to note that if the discharge pipe were installed as in Fig. 2, the water would pour from the elevated cooling coils against the full atmospheric pressure of 14.7 lb absolute. On the other hand, if the discharge pipe is installed as in Fig. 1, and drops a sufficient vertical distance so that an absolute pressure of, say, 10 ft of water (corresponding to a vacuum of 21 in. of mercury) can be maintained at the outlet of the coils, the head against which the pump must deliver the water will be correspondingly reduced. Thus, for the installation of Fig. 2, the water leaving the coils must be pumped from the coils against an absolute pressure corresponding to 34 ft (14.7×2.3) of water. For the conditions of Fig. 1, with an absolute pressure of only 10 ft of water at the outlet of the coils, it is evident that the head of water against which the pump must work will be reduced by 24 ft (34 — 10), with a corresponding reduction in the cost of operation.

The saving to be realized by maintaining a vacuum at the top of the discharge pipe, depends of course upon the conditions surrounding each individual job. It may amount to very little or it may amount to a substantial percentage. How-

[1]Friction in a pipe in which water is flowing downward will increase the static value of 2.3 ft slightly, but this value may nevertheless be used for illustrative purposes. In a pipe in which the water is flowing upward, the static value of 2.3 will be decreased slightly by friction.

ever, the total pumping head on most air conditioning jobs is sufficiently low so that a reduction of 24 ft is often a very substantial percentage of the total head. Occasionally when city water is used, its pressure may be just high enough so that by utilizing the discharge pipe to maintain a vacuum, a pump may be dispensed with entirely where one would otherwise be required.

In figuring the head on a pump, or whether a pump is required, the net pumping head should be figured exactly as if the piping were installed as illustrated in Fig. 2. Then the saving in head due to the reduced outlet pressure should be subtracted in order to find the net pumping head. The saving in head is always the difference between the absolute atmospheric pressure of 34 ft and the lower absolute pressure which can be maintained at the outlet of the equipment by the vertical discharge pipe.

Although many jobs are installed with discharge pipes as illustrated in Fig. 1, they nevertheless actually operate exactly as if they had been installed in the manner illustrated in Fig. 2. The water pours from the coil against atmospheric pressure because the discharge pipe is only partially filled, and the water falls freely in the pipe exactly as it does in a vertical drain pipe. This point will be discussed in more detail later; it is mentioned here only to emphasize that the installation of a vertical discharge pipe does not mean that a vacuum can be maintained at the top. Certain precautions and attention to simple design details must be observed in order to produce the desired result.

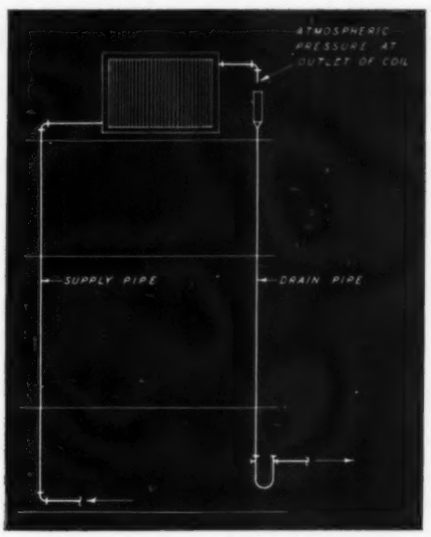


Fig. 2—For an installation like this, the water leaving the coils must be pumped against an absolute pressure of 34 ft of water, while for the conditions of Fig. 1 the head against which the pump must work is reduced

Pressure at Top of Vertical Discharge Pipes

Theoretically, the absolute pressure at the top of a discharge pipe can he reduced to zero by making the vertical drop long enough. Although the discharge pipe can often be made long enough vertically, the pressure at the top can never fall to the absolute zero of pressure for two reasons. The first is that the water will vaporize when the pressure falls to the saturation pressure corresponding to its temperature. Thus water at 55 F will flash into steam when its pressure is reduced to 0.214 lb absolute, or 0.49 ft of water (0.214 × 2.3). If the water has been discharged from a condenser, it may be at a temperature of 100 F, and hence will vaporize when its pressure falls to 0.949 lb absolute, or 2.2 ft of water. If sufficient vapor forms at the top of a discharge pipe, it can interrupt or break the continuous stream of water and the flow may cease.

The second reason is that all ordinary water contains some air in solution, and a reduction in pressure or a rise in the temperature of the water will free this air. Since both a reduction in pressure and a rise in temperature (due to the heating effect of the air cooling coils or the condenser, as the case may be) takes place at the high point of the piping, bubbles of air will be released. If enough air accumulates, it can also break the water column.

For these reasons, and also to provide a safety factor, it is desirable to so design the discharge pipe that not less than an absolute pressure of about 10 ft of water (a vacuum of about 21 in. of mercury) will be maintained at the top. It may be that in time, if this method comes into extensive use, that an absolute pressure lower than 10 ft of water will be found practicable. Until then, it would seem advisable to use this as a minimum value.

Design of Vertical Discharge Pipes

The entire success of a piping system utilizing a vacuum at the top depends upon the design of the vertical discharge pipe. Fortunately, the conditions that must be satisfied for a successful design are relatively simple and are easily achieved. The principal condition that must be satisfied is that regarding the vertical drop of the discharge pipe. Taking into account pipe friction and possible pressure drop due to a valve at the outlet of the discharge pipe the following formula can be used to find the required vertical drop:

$$L + P_T = P_o + F \quad \text{.....[1]}$$

where

L = *Vertical drop* of discharge pipe, ft (See Fig. 1),

P_T = Absolute pressure, ft of water, at top of discharge pipe,

P_o = Absolute pressure, ft of water, at outlet of discharge pipe,

F = Friction head lost in discharge pipe only, ft of water.

(Formula 1 is simply a statement of Bernoulli's theorem applied to a vertical pipe of uniform diameter in which water is flowing downward.)

The pipe friction F is only the head lost in the dis-

(*Continued on page* 426)

When water using air conditioning equipment must be situated above the source of water supply and a vertical discharge pipe of some length can be installed, it is often possible to reduce substantially the head against which the pump must deliver the water. No special equipment is needed, only an awareness of the possibilities of utilizing the energy of the falling stream of water, and some attention to a rather simple design and installation procedure. . . . The scheme is described here, and instructions for utilizing the principle are given in detail

Correct Piping Layout Important for Diesel Engine Installations

By C. T. Baker*

The importance of proper layout of exhaust, air, oil, and water piping for diesel engine installations is outlined here, and suggestions for piping for these services are given, based on the author's wide experience with such plants

DURING the past few years, many diesel engines have been placed in service for supplying power in industrial plants and municipal stations. It is important that such installations have proper exhaust, air, oil, and water piping layouts.

Exhaust Piping Must Not Restrict Flow

One of the principal considerations in connection with the piping layout of a diesel engine plant is that of the exhaust. If such piping is unnecessarily long, or too small in diameter, with unnecessary right angle elbows, serious trouble may occur due to abnormal exhaust back pressure.

Any type of internal combustion engine must have an unrestricted exhaust, otherwise a power loss will result. For the same reason it is important that exhaust silencers or mufflers, when used, be of ample capacity to permit of free passage of the exhaust gases. Provision should be made to care for contraction and expansion of exhaust lines to protect both engine and piping from damage.

Where conditions require long exhaust lines and numerous elbows, the diameter of both the pipe and fittings should be increased sufficiently to avoid too high back pressure. If the exhaust must pass through the wall or roof of a non-fireproof building, a sheet steel or galvanized iron thimble should be inserted in the roof or wall for the pipe to pass through. These thimbles should be at least 12 in. larger in diameter than the outside diameter of the exhaust pipe.

Provide Filter for Air Intake

The air intake should always be provided with a suitable air filter to protect the engine cylinders from grit or other foreign matter; such filters must, of course, be of ample capacity to permit free and unobstructed passage of air. This same precaution is essential to the air intake pipe between filter and engine.

When installing air intake mains and connections, all pipe and fittings should be thoroughly cleaned as the work progresses; unless this is done, damage to the engine cylinder is almost certain to result.

Exhaust and air intake piping is usually heavy on account of the size required and, because of this, proper supports must be provided. Failure to do this will cause trouble that might easily result in serious damage to the engines.

Where the air injection type diesel engine is used, high pressure air is required for fuel injection. Likewise, high pressure is frequently required for starting duty.

The usual specifications covering such service provide that all high pressure air piping be extra heavy annealed and tested seamless drawn steel tubing with special high pressure fittings, and all high pressure air tanks or air bottles are required to be constructed from seamless drawn steel and provided with approved safety valves and fusible safety plugs for pressure relief in case of fire. All such pressure tanks are required to be manufactured, tested, inspected and stamped in accordance with Shipping Container Specifications 3-A, I. C. C.

In the case of solid injection engines, air is used for starting duty only, and usually this will require pressures of from 225 to 250 lb; however, all air tanks should be tested for high pressure and all fittings used on the air starting piping system should be extra heavy. Any attempt to use 125 lb working pressure fittings for this service will prove expensive in the long run. A few years ago, the author, in making an investigation of a diesel power station which had been in service about a year, discovered that light cast iron fittings had been used on air lines carrying 225 lb pressure. No serious trouble had occurred up to this time but these fittings were shortly removed and replaced with high pressure fittings as a matter of safety.

All air receivers for starting duty should be built in accordance with the *A. S. M. E.* code for unfired pressure vessels with each tank stamped with the official inspection stamp.

A drain of not less than 1 in. diameter should be provided at the bottom of such tanks for the removal of oil and water at regular intervals.

The Water and Oil Piping

Internal conbustion engines require considerable water for circulation through the cylinder cooling jackets. Such water supplies may be taken from overhead tanks or from city mains or any other dependable source. In some instances cooling towers or spray ponds are used; then again, the closed circuit of water supply is often used.

Regardless of the system employed, proper piping layout is essential; too often, water supply piping systems in diesel and gas engine plants are erected without regard to the requirements, with the result that both safety and continuity of operation are jeopardized.

If the piping layout is such that a continuous and adequate supply of cooling water to the jackets is not possible, damage to engine cylinders will occur. One of the essential requisites of such piping layouts is, first, that the water lines be as short and direct as possible and free from pockets, and second, that all pipe be

*Consulting Engineer.

reamed at the ends to avoid reduction in area due to shoulders caused by the use of pipe cutting tools.

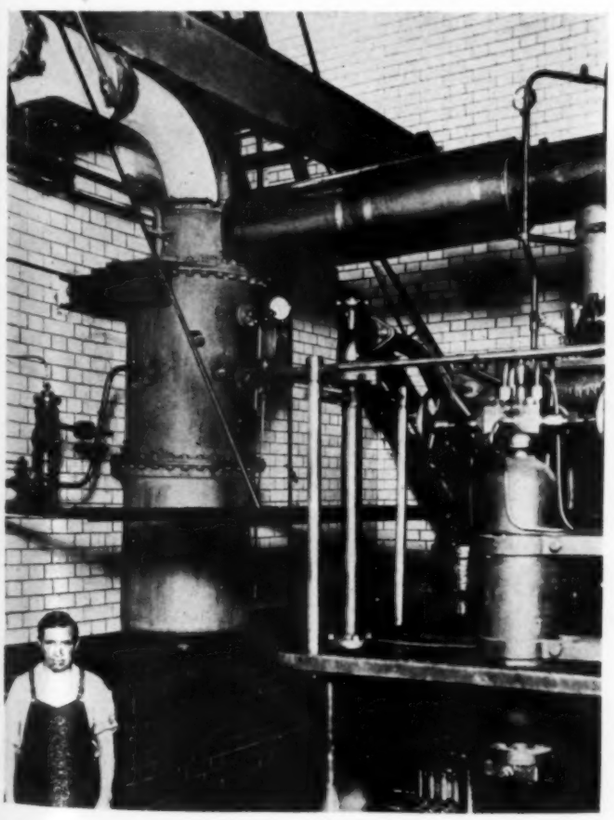
Wherever possible the outlet pipe from the cylinders should be so arranged as to enable the operator to see the overflow. Usually this can be effected by the use of a goose-neck connection on the water outlet so arranged that the overflow water will fall into a funnel opening on the water outlet header. By this means the operator can tell at a glance whether or not each individual cylinder is receiving sufficient cooling water.

In laying out the water supply system the general arrangement should be simple and the pipe area large enough to insure an inlet pressure to the cylinder jacket of not less than 15 to 20 lb. Thus if an overhead supply tank is used such a tank must be elevated sufficiently above the overflow outlet connection to insure the required inlet pressure.

Where cooling towers are used, situated at or near ground level, the circulating water pump discharge should preferably be taken to an overhead tank with the outlet of this tank connected to the jacket water inlet. This will insure constant pressure in the supply.

The overflow water from the overflow header is delivered to the top of the cooling tower. The cooling tower is usually situated on a concrete basin to which the circulating water pump suction is connected. The bottom of the water supply tank should be placed at least 15 ft above the point where the jacket water returns to the cooling tower. The overhead tank should have a capacity of from 5 to 6 gallons per rated engine horsepower but where conditions permit, larger capacity tanks are advantageous. Drain connections should be provided to permit draining the entire system when necessary.

Exhaust piping and small waste heat steam boiler at a 300 hp diesel electric plant where the heat of the engine exhaust is used for generating steam



It is important that the design of the water system as a whole be in accordance with best commercial engineering practice so as to insure that pumping costs will not be excessive.

Obviously, the first thing to consider is how many gallons of water per minute must be circulated to meet the engine cooling requirements. This will depend upon three main factors; namely, capacity of plant, temperature of the inlet water to the cylinder jackets and allowable outlet temperatures. It is of course necessary to provide a supply that will meet the full load requirements but generally 6 to 10 gallons of water per brake horsepower-hour is required. If, however, the initial temperature is low, say 60 to 70 degrees, and the character of the water is such that a run-off temperature of, say, 130 degrees is allowable then 4 to 5 gallons per bhp-hr may be sufficient.

Wherever possible, pump suction lines should be of sufficient cross sectional area so that the velocity of the water does not exceed 240 feet per minute, while the delivery line should be large enough in diameter to insure a velocity of not over 300 feet per minute. Such velocities may of course be exceeded, but always at the cost of power.

The selection of the proper pump is likewise important and even in the smaller size pumps, it will pay to select a pumping unit that is guaranteed to operate efficiently since the difference in first cost of an efficient pump over an inefficient one will soon be realized in power savings.

Suction lines should be as short and direct as possible with the fewest possible sharp turns and elbows and wherever it is necessary to lift water from an elevation below the suction inlet, the vertical distance should not exceed 20 feet. Better results may be obtained if this distance can be limited to 15 to 16 feet.

Regarding the lubricating oil piping, the engine builders usually supply all of the piping on the engine proper, while the purchaser usually provides piping external to the engine. Often, the lubricating system may be rather elaborate since in many installations oil coolers are provided, as well as oil purifying systems which call for a more complicated piping layout. However, it should be emphasized that the additional first cost of oil cooling and oil purifying equipment is a good investment.

It goes without saying that no shoddy work should be permitted in connection with oil piping system layouts and that such systems should be amply protected with necessary bypasses, safety valves, stop valves, etc.

It is imperative that all pipe used in the erection of the oil piping layout be thoroughly cleaned so as to remove any abrasive matter that will later get into the bearings and cause damage. Some engineers do not provide trenches for the oil lines external to the engine but simply bed them in the concrete floor. This is a mistake and might result in trouble.

The suggestions and recommendations made in this article are not offered as anything new or original but simply to indicate some of the things that the author has experienced in engineering practice during the past several years.

How Can We Stop Corrosion of Our Air Conditioning Equipment?

. . . . asks the chief engineer of an industrial plant. Suggestions by two authorities are given

CORROSION of air conditioning equipment quite frequently is an operating and maintenance problem which is difficult to solve. Recently a reader of HEATING, PIPING AND AIR CONDITIONING—chief engineer of a manufacturing plant troubled with corrosion of refrigeration equipment used in conjunction with an air conditioning system—asked for aid in determining the correction of a difficulty of this kind, and it is felt the suggestions made to him will interest others faced with similar situations. Perhaps, too, other readers will have had comparable experiences; the editors will welcome contributions on combating corrosion of air conditioning equipment and those published will be paid for at regular rates.

Here is the problem: "We are troubled with corrosion in our refrigeration plant which is used in conjunction with an industrial air conditioning system. We have a 400 ton ammonia compression plant and use a spray pond on our condenser.

"While the corrosion is bad in all pipe lines, air conditioners, and in the multi-tube condenser, the most rapid corrosion occurs in the shell and tube type coolers where the temperature is lowest (around 36 F.)

"We have tried controlling the pH with soda ash, also sodium silicate, without any apparent change in the corrosion rate on the cooler tubes. We have not tried potassium chromate as we force our air conditioners in bad weather and are afraid of the effect of carryover. Painting has been some help but is a laborious process.

"Have others using very cold water sprays in air conditioners experienced the same trouble? What is the usual procedure in attacking the trouble?"

In answering the question, one authority on corrosion points out that the solution of a problem of this kind requires a thorough knowledge of local conditions, and any definite recommendations must be based on a thorough inspection of the plant. In some cases corrosion in tube and shell coolers occurs almost entirely at the ends, and this has been satisfactorily remedied by inserting a metal flanged tubular sleeve about 18 in. long which tightly fits the end of the tube and protects it from corrosion and erosion to a large extent.

Treatment of the Water Recommended

Air conditioning systems and exposed condensing equipment offer very severe service conditions for materials. Highly corrosion resistant alloys are as yet too expensive to be universally justified. One alternative is treatment of the water. The conditions existing in a dehumidifier may be quite severe, as the steady influx of air contaminated with sulphur dioxide and suspended particles quickly builds up corrosive constituents in the wash water and often reduces the pH to about 3 or 4. Water of this acidity must be continuously treated if its corrosive attack is to be controlled, the most effective treatment at present being the addition of potassium dichromate with sufficient caustic soda to convert it to the chromate. This has been successfully used in concentrations of from 50 to 500 ppm potassium dichromate, depending upon conditions.

The possibility of carryover of the dichromate is, of course, of importance. However, unless the dehumidifiers are overloaded there is little danger of this. Sterne (*Proc. A.S.T.M.* 35 Pt. II, 261-274, 1935), in one installation where dichromate treatment was in use, found 0.00066 mg sodium dichromate per 100 cu ft of air at one delivery port but none at the others. The wash water contained 504 ppm sodium dichromate and 420 ppm sodium silicate (as SiO_2) at a pH value of 8.9.

The *American Society of Refrigerating Engineers* in their investigation of corrosion in refrigerating systems (see F. N. Speller, "Corrosion, Causes and Prevention," 1935, pp. 372-374, 615-619) recommended sodium silicate for certain fresh water cooling systems. The amount suggested was 20 ppm NaOH from sodium silicate corresponding to 15.6 lb 40° silicate per 1000 cu ft of wash water. This should be the minimum. Concentrations up to 500 ppm sodium silicate (as SiO_2) have been used, the protection increasing as the concentration increases; at this high concentration, however, deposition of salts may occur. Sodium diphosphate with the dichromate has proved better than the dichromate alone. The amount and kind of inhibitor should be selected to suit the water to be treated.

Under the conditions stated by the inquirer, possibly the use of a fairly high concentration of silicate, 200 to 400 ppm with a small amount of dichromate, say 50 ppm may be effective. Carryover of dichromate could be checked when the dehumidifier was running heavy. Close control is necessary. The pH should be maintained around 8.5 and should not be allowed to drop below 7.5.

Examination of the installation under consideration might modify or change these suggestions, of course.

Another writer on corrosion, C. M. Sterne,* to whom the problem was submitted, replies as follows:

The finding of the most corrosion at the point where the water is coldest is contrary to what might be ex-

*Chief Engineer, Metropolitan Refining Co., Inc.

pected. However, it is probable that the corrosion rate is accelerated in the cooler because of what is called differential oxygen concentration, or to water swirl. This, of course would be due entirely to the design of the shell and tube cooler. This particular form of corrosion has been found in condenser tubes in marine and land power plants in a great number of cases. In marine and land power plant condensers, where it is impossible to treat the water which is sent through the condensers and then allowed to run to waste, the problem has been solved by using more corrosion resistant metals, such as the copper nickels, monel, chromium iron, and chromium nickel iron alloys, etc. The cuprous alloys could not be used with ammonia.

I have no doubt that an alkali such as soda ash, caustic soda, or the soluble silicates could not be very effective in controlling this particular type of attack. It is necessary to carry the proper concentration of chromates in the recirculated water; this concentration is dependent upon the chloride and sulphate concentrations of the water to be treated and should be carefully controlled. Frequent check analyses should be made by a recognized laboratory and daily determinations of the chromate concentration should be made in the plant. This is a simple procedure, and is done by the operating force of many air conditioning systems. In using chromates for corrosion passivification, it is not necessary to maintain a high pH value in the treated water. A pH value of 7.5 to 8.0 is sufficient as has been proved by many corrosion tests made by the writer and others.

The matter of the possibility of carryover from air washers and dehumidifiers has been gone into very thoroughly by agencies of the federal government, several of the large research laboratories, and by a number of university laboratories.† In every case metered samples of air were sucked through distilled water and tests were then made to determine if any chromates were present. Diphenyl carbazide was the reagent used, which perhaps is the most sensitive to chromates. Altogether, to the writer's knowledge, over 100 tests have been made of conditioned air where concentrations up to as high as 580 ppm of chromates were carried in the wash water. In one case there was a trace of chromates found in the conditioned air. This concentration was 0.00066 mg of sodium dichromate per 100 cu ft of air. All other tests were entirely negative as to chromates. The medical department of this particular organization decided that there was no danger to personnel or equipment.

In most cases a concentration of 200 ppm of sodium dichromate is sufficient to give corrosion protection. If eliminators that take out the entrained water are in the air washers no possible carryover of chromates or any other dissolved solids in the wash water may be expected to be found in the conditioned air.

†The matter of carryover is important because of the possibility of "chromate itch" if the spray were not correctly eliminated from the supply air.—Ed.

How Heat and Ventilate a Garage?

. . . . asks a reader, who is answered by Samuel R. Lewis*

WHAT type of heating unit should we use in an air conditioner on a vacuum steam boiler?, a reader asks. He continues: "We wish to air condition and heat the offices of a garage; that is we do not want to use a split system in the office, although the garage part of the building will still be heated with the cast iron steam radiators and this part will not be air conditioned. The heating plant is a steam boiler of the vacuum type.

"Are heating coils suitable when the heating plant is operating under its vacuum?"

ANSWER—Apparently it is desired to install a ventilating machine comprising a fan, convector, mixing damper and filter for ventilating the office of a garage.

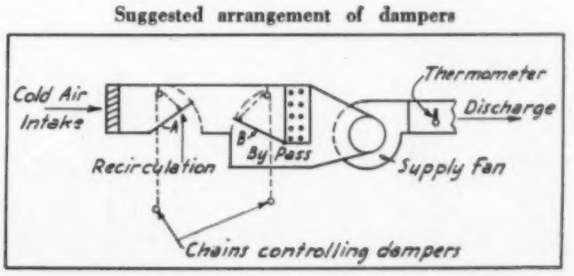
It would be wiser to install for the office sufficient direct radiation to accomplish the heating independently of the ventilating unit. This would permit keeping the office warm at night and on holidays without operating the fan.

It seems doubtful whether a small unit of this sort will have automatic temperature regulation. Heating coils are suitable for heating the outside air using steam from a vacuum system. It is important, of course, to make provision so that these quick acting surfaces shall not be frozen. The best way is to locate them well above the boiler and vacuum pump, and not to attempt to control the steam supply with valves. If valves are used and are closed while steam or water remains in the tubes, the latter can be frozen in a remarkably short time. Any valves, therefore, should be employed only for emergency use. The usual vacuum traps will of course be furnished.

Small ventilating systems of this sort sometimes are installed with a manually operated recirculating and outside air damper *A*, and with manually operated mixing damper *B*, as shown by the sketch.

The heating coils are always heated so long as there is any steam available. The mixing damper *B* especially must be arranged as shown, facing the air current as in no other way does the scheme work satisfactorily. Damper *B* can be adjusted by occasional reference to the thermometer in the side of the discharge duct, to give a constant delivery temperature so long as the steam pressure and outside temperature remain constant. Damper *A* closes off the outdoor air entirely or permits a minimum volume of outside air, as may be desired in chilly weather, or may allow 100 per cent outside air as will be desired during mild weather or in summer. If automatic temperature control is to be used, then damper *B* can be replaced with conventional face and bypass dampers, but still no control valves should be installed in the steam supply to the convector.

Suggested arrangement of dampers



*Consulting Engineer. Member of Board of Consulting and Contributing Editors.

American Practice in Panel Heating

ABOUT nine years ago a system of heating originated in England was introduced in the United States. In brief, it consists of coils of pipes embedded in the construction of ceilings or walls to form panels. In England the system had been called "panel warming," a term which was changed to "panel heating" upon its introduction to this country.

Since 1928 a number of panel heating installations have been made in America. As with any comparatively new method of heating, the experience gained in these installations has been invaluable. Each has been carefully checked, and a number of interesting observations have been made which have proved the practical efficiency of panel heating, and at the same time have produced an experience record upon which future installations will be based.

Before any demonstration of the system had been made, there seemed to be a question as to whether comfortable conditions could be produced in this country by means of this type of radiant heating system. For a number of years, panel heating had been used in England, but, due to the lower temperatures encountered in this country, it was not instantly apparent whether an installation of this kind would work equally well. The proof that it does work to produce comfort conditions, when properly installed, in any range of temperature, is evidenced by its successful use in the British Embassy at Washington, D. C., the William Goadby Loew residence in New York City, and a number of other buildings including the tubercular wings of the Metropolitan State Hospital in Waltham, Mass., and the Colonel H. H. Rogers residence in Southampton, N. Y.

By Leon L. Munier*

But little information has been published on American practice in panel heating, European engineers having had more experience with this method of heating buildings than have we in this country. The author has therefore endeavored to describe how the method is applied in the United States and how panel heating practice here varies from that abroad

Finished ceiling with panel coils

Lower Air Temperature

These installations take advantage of the fact that lower air temperatures can be maintained to produce comfort conditions in any type of interior, provided that sufficient radiant heat is emitted from properly located and heated panels. Tests in the Loew house, for example, since 1931 have indicated that comfort has been maintained even in protracted periods of cold weather when the temperature reached 15 F below zero. Other tests indicate that interior air temperatures can be around 63 F when a panel heating system is used and comfort conditions will be equal to those obtained in a room with air temperatures of 70 F or more produced by a conventional heating system.

Experiments with various types of radiant heating have indicated that the temperature of surrounding surfaces has more influence on comfort conditions than does air temperature. They have shown that, in a room with air being introduced at more than 100 F, but with surfaces maintained below 60 F, an uncomfortable sensation of chilliness was evident. When the conditions were reversed, however, so that the temperatures of the surfaces were over 80 F, air could be introduced well below 30 F without producing discomfort. Further, it has been demonstrated that the optimum conditions for an American comfort standard can be most easily produced when the air temperature remains between 60 and 65 F and the temperature of the panel heating surfaces is varied to conform with the outside weather conditions.

The design of panel heating systems in this country varies considerably from English practice. There, the air temperature rarely exceeds 65 F and is usually close to 60 F even with a conventional heating installation. A comfort standard in this country is different and experience justifies the statement that air temperature much under 70 F would be uncomfortable in the average American building with a conventional installation. Therefore, all panel heating systems installed in this country must be designed to meet American standards.

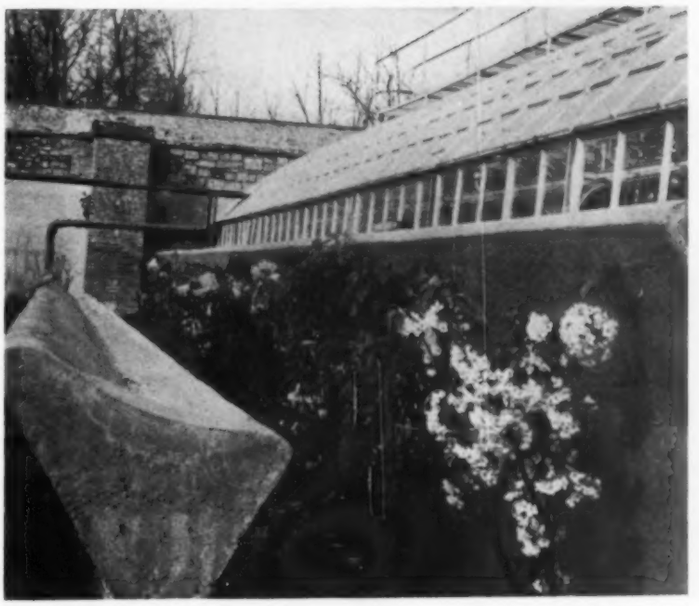
Panels Situated in Ceiling

Panel systems have been installed with heating panels in floors, walls and ceilings. However, experience so far has indicated that the ceiling location generally produces best results. Heat rays can be distributed more uniformly and will cover the entire room area with less chance of interception, thereby producing a more truly radiant effect. Panels in floors and walls tend to act partially as convectors and will set up convection currents. The ceiling installation has been found to pre-

*Wolff & Munier, Inc., U. S. Licensees, Richard Crittall & Co., Ltd.

vent a large air temperature difference within the room; on the average, there is rarely over a 2 F difference in air temperature between floor and ceiling.

Because radiant heat emitted from a surface travels in a manner comparable to rays of light, it is important that panel surfaces be well distributed throughout the room. The extent of the panel areas is calculated from the heat losses of the room, but it is essential that the radiant heat from the panel be distributed evenly. Interior spaces that have no heat losses must have panel areas. Otherwise, comfort will not be equal throughout the area, due to the lower air temperature which ordinarily prevails.



Plants have been grown outdoors subject to temperatures as low as 12 F, the heating coils being buried in the ground and built into concrete panels like walls, as shown here. Photograph taken December 23, 1936

Due largely to the low water temperature used with the system, results obtained from panel systems have been quite satisfactory in rooms as low as 8 ft. Most installations have been made in rooms from 9 to 12 ft high, with some as high as 18 ft. The maximum water temperature is 135 F, and in the majority of systems has been regulated by a two-point control. The water temperature is reset according to the outside temperature and thereby produces not only greater average comfort but a greater economy of operation.

Determining the Panel Area

The method of determining the panel area is the same as with any other heating system, that is, the heat losses of each room are figured according to the exposures.

After the panel surface has been determined, the location of coils and panels depends entirely on the layout of the room. In general, of course, panels are placed around the outside surfaces, although they must also be situated so that no large area of the room is without any panel surface. For instance, in the hospital building in Waltham, Mass., the wards that have one side exposed only, this side having windows, have a coil within 2 ft of the outside wall extending into the room and another coil spanning the area from the inside of the first coil to the inside partition line. There is a void about 4 ft between the coils and approximately the same amount between the second coil and the inside partition.

In a room that is exposed on several sides, the transmission losses are such that a large part of the ceiling must be used for panel areas to take care of the heat losses. The division of the panel area into separate coils is a question of design, entirely predicated on distribution of controls, ease of connections, etc.

As far as the piping layout is concerned, the system consists entirely of a forced hot water design, similar to any other hot water system. Normally, a down feed system with an overhead supply main and a bottom return main is used. Many systems in Europe, however, have been put in as straight upfeed systems, venting the tops of the risers, or else with a supply main at the bottom and return main at the top.

In the Crittall system of panel heating, coils of extra heavy steel pipe are welded together and are situated just behind the finished surface of the room. The panel itself is heated by direct conduction from the pipe coils and the heat emitted from the panel surface by radiation.

Installations made in this country since the British Embassy have had panels formed by hanging coils below the arch construction, and applying wire lath and plaster to the underside of the coils. Above the coils 2 in. of cork or some similar insulator has been used to prevent heat losses into the hung ceiling space.

In the British Embassy, as well as in most European installations, the arch construction has been of the flat bottom arch, so that the coils have been cast in the bottom of the slab. This form of construction, of course, requires no insulation above the coils and no special coil hangers. The initial cost for such an installation is considerably less than that described above. In Europe, with this type of construction, panel heating systems can be installed as cheaply as convection heating systems.

When coils are cast into the floor slab, the entire mass becomes heated, producing a lag in the operation of the system. This lag is an advantage so far as operating cost is concerned, for it does not permit the building to cool as rapidly as is otherwise the case. In office buildings, stores, public buildings, etc., where systems are normally shut down for the night, for Sundays, and for holidays, this lag eliminates the need for operating the system to prevent undue chilling of the building while not in use. Tests made in Europe have shown the temperature drop during the night to be only a few degrees.

In residential work this lag would be a serious handicap, as the heat could not be turned off quickly. With the type of installation made in this country, the lag is absent because coils are free of major items of building construction. They are only in direct contact with the lath and plaster of a hung ceiling.

Plastering Method Important

The method of plastering panel surfaces is one important point in a panel system construction. It is

Above—American construction with coil hung below arch. *Below*—European construction with coil to be cast in arch

essential that the plaster be in intimate contact with pipe coils and also that it does not crack after the system is in operation. Plastering should be done in three coats, and a lime used that has a high calcium content. In applying the first coat, the plaster must be forced into the wire lath so that it will surround pipe surfaces thoroughly. If this is not done, panel surfaces may not heat as a unit because proper contact between pipes and plaster is absent. The second coat of plaster is applied similarly to the usual brown coat. In applying the third coat, it is essential to work a reinforcing scrim into the plaster. This is similar to jute bagging cloth, having about 8 meshes to the inch, and prevents cracking of finished surfaces.

Two particularly interesting facts have been brought out during the installation of American panel heating systems. The first is the fact that color has an influence on the efficiency of the panel. A dark floor, for example, will tend to absorb radiant heat, whereas a light color will tend to reflect the heat. Similarly, a hard surfaced material (such as white tile) does not absorb much radiant heat. In one installation where tile was used to enclose the area, it was found necessary to increase the capacity of the heating panel to produce the desired condition of comfort.

The Patent Situation

In Europe, the development of panel heating has progressed greatly. Some years ago, the Crittall licensees formed an association called the "Stralingswarmte," with headquarters in Holland, the purpose of which was to centralize all engineering design, testing, research work and buying of materials for panel heating systems. Two years ago, a Swiss engineer, R. Deriaz, designed a radiant heating system using the floor as the radiant surface, and using extended metal surface in contact with pipe coils heated with steam or high temperature hot water. This system has had considerable success in France. Last year the Stralingswarmte group combined these patents with the Crittall patents and included others covering panel heating so that the group now controls most of the European patents which have been registered throughout the world.

Greenhouse Heating and Plant Culture

Extensive experimenting has been done in panel heating for greenhouses and for plant culture outside of any building structure during the winter. Azaleas, mimosa, lilacs, and tulips have been grown and brought to bloom, strawberries, radishes, potatoes, etc., have been grown where these plants were outside of any shelter and subject to temperatures as low as 12 F and to a snow fall of 4 in. The heating coils are buried in the ground and built into concrete panels like walls so that the plants are always subjected to radiant heat.

Experiments have also been made with cooling, using well water through a heat exchanger to cool the water circulated in the panel systems. Chemical means of dehydrating the air were used to maintain a low relative humidity to prevent condensation forming on the cooling panels.

[*Continued from page* 419]

charge pipe between the points where the pressure P_T and P_o are measured. If there is no restriction at the outlet of the discharge pipe, the pressure P_o will be atmospheric, or 34 ft absolute.

As an example of the use of Formula 1, if the friction loss in a discharge pipe for a known rate of flow is 6 ft of water, and an absolute pressure of 10 ft of water is to be maintained at the top, then (according to this formula) the vertical drop of the discharge pipe must be 30 ft, as computed in the footnote.[2] If a higher absolute pressure, say 15 ft, is to be maintained at the top of the discharge pipe, then (for the same conditions) the vertical drop need be only 25 ft. The pumping head saved is equal to 34 ft minus the pressure maintained at the top of the discharge pipe.

Sometimes the vertical drop may be limited by building conditions. In this event, Formula 1 can also be used to find the lowest pressure that can be maintained at the top of the pipe. The top pressure can be reduced to a minimum by using as large a discharge pipe as is practical, thus reducing the friction loss. Thus, if the vertical drop is only 20 ft, the pipe friction loss is 2 ft, and the pressure at the outlet of the discharge pipe is atmospheric, the lowest absolute pressure that can be maintained at the top of the discharge pipe will be 16 ft absolute, according to Formula 1. The saving in pumping head under this condition will amount to 18 ft (34 — 16). The pressure at the top of the discharge pipe should be kept as low as possible if the head on the pump is to be reduced to a minimum.

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[2] $L + P_T = P_o + F$ (Formula 1)
$L + 10 = 34 + 6$
$L = 40 - 10 = 30$ ft

[*To be concluded*]

Modern air conditioning, generally acknowledged as born in the spinning room of a cotton mill some thirty years ago, is today essential to the manufacturing process of another branch of the textile industry—rayon. In fact, it has been said that there would be no rayon industry were it not for air conditioning. . . . To the National Rayon Technical Conference at Washington, D. C., recently—commemorating the 25th anniversary of the manufacture of rayon in the United States—Mr. Lewis presented a comprehensive paper on air conditioning for textile plants making and using synthetic yarns. Because of the importance of air conditioning to the process and as an example of what air conditioning means to modern industry, the part of his paper dealing with the conditioning requirements is published

Rayon and Air Conditioning

How Rayon Is Made

Air Conditioning Requirements of the Process

By L. L. Lewis*

THE first seven steps in the manufacture of rayon by the viscose process (shown diagrammatically on the next page) and the air conditioning requirements were described in the first part of this article, which appeared in the June issue.

Step 8—Cake Storage. Up to this point, the viscose process is a continuous one which must necessarily be carried on 24 hours a day and seven days a week. Once the process is stopped, all machines must be cleaned of solution in process which quickly deteriorates and solidifies. No more need be said for the necessity of equipping with apparatus which is thoroughly reliable and which can be kept in sustained operation.

The cake storage room or its equivalent becomes the reservoir in which the accumulation of continuous production is held pending the subsequent process, which may be and usually is an intermittent one and in which the spun yarn is either treated in the cake or reeled.

Where the cake storage system is in use, the storage rooms are normally placed between the spinning room and the reeling room. The cakes are saturated with acid and still subject to a crystallization which must be avoided.

It is desirable to hold temperature at approximately 85 F with a condition of fog or supersaturation. Since the storage room has no internal heat gain, the problem is one of winter air conditioning. Atomizing sprays are satisfactory and no air motion is required.

Step 9—Reeling and Lacing. In this operation, the rayon threads are wound from the cake form into skeins, which are laced or tied together with the bands colored for the purpose of identification.

The material is still subject to crystallization and, therefore, the same conditions of temperature and humidity required for the spinning process are needed.

Since the volume of air exhausted from the spinning room is greatly in excess of that required to condition it, less air conditioning equipment is required if all outside air is used for the reeling room and then permitted to flow from reeling to spinning through large passages left for that purpose. This scheme has two advantages: It gives a high quality of ventilation for the reeling room and utilizes the internal heat gain of the reeling room to reheat part of the spinning room supply. As in the spinning room, evaporative cooling equipment is required; good air distribution is required with air motion limited by the delicacy of the threads.

Steps 10 to 14 Inclusive—Washing, Drying, Desulphurizing, Bleaching and Centrifuging, Final Drying and Conditioning. Except for the drying process, the need for air conditioning is limited to heating, in the design of which some consideration must be given to the vapors arising from washing operations. Improvement of machine enclosures has, however, so reduced the quantity of vapor released that the prevention of roof condensation is hardly a problem. The attack upon this problem is well standardized and not looked upon as within the scope of this treatise.

The necessary drying may be accomplished in a number of ways. It is generally known that well developed

*Vice-President and Chief Engineer, Carrier Corp.
Concluded from June issue, pp. 347-350.

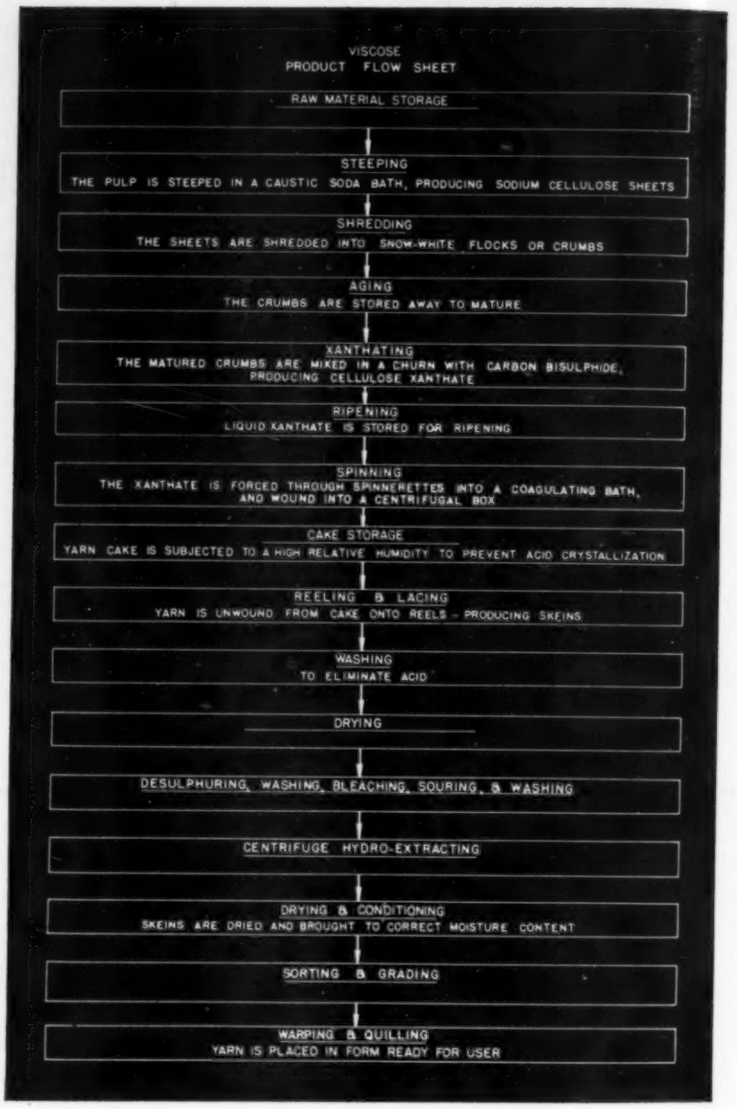
equipments, such as the hurricane and other dryers, are available for this purpose. A very considerable latitude in design and selection of equipment may be had.

The principal objective of the first drying process is finally to stop chemical reaction, which is considered to have been proceeding at a very slow rate up to that point.

The necessity for final drying is obvious and the importance of the control of regain in the final product is of vast importance. Although the final regain of the product is eventually fixed in a subsequent process, it is good practice closely to regulate regain in the final dryer. The burden of making up any deficiency of regain may be placed either upon the subsequent process or upon the final dryer. Practice, however, has proven that the best results can be accomplished at maximum economy by sending the product to the following process at a constant regain equal to or slightly higher than the ultimate. Best results are obtained by slightly subdrying the yarn at a temperature which usually does not exceed 120 F and then cooling it while bringing its regain up to the desired point in the conditioning sections of the dryer. Evaporative cooling equipment is required for the regain section of the dryer.

A regain of 10 or 11, corresponding to approximately 60 per cent relative humidity, is desirable. This is slightly higher than that of the final product but a considerable part of the excess flashes off because, as a practical measure, the product leaving the conditioning section is not cooled all the way down to room temperature.

Slight variations within the bulk of the product are permissible since exposure in the subsequent process affords ample opportunity for diffusion and conditioning to afford uniformity. It should be noted, however, that a deficiency of regain puts a corresponding load upon the air conditioning equipment for the processing department.


VISCOSE
PRODUCT FLOW SHEET
RAW MATERIAL STORAGE
STEEPING
THE PULP IS STEEPED IN A CAUSTIC SODA BATH, PRODUCING SODIUM CELLULOSE SHEETS
SHREDDING
THE SHEETS ARE SHREDDED INTO SNOW-WHITE FLOCKS OR CRUMBS
AGING
THE CRUMBS ARE STORED AWAY TO MATURE
XANTHATING
THE MATURED CRUMBS ARE MIXED IN A CHURN WITH CARBON BISULPHIDE, PRODUCING CELLULOSE XANTHATE
RIPENING
LIQUID XANTHATE IS STORED FOR RIPENING
SPINNING
THE XANTHATE IS FORCED THROUGH SPINNERETTES INTO A COAGULATING BATH, AND WOUND INTO A CENTRIFUGAL BOX
CAKE STORAGE
YARN CAKE IS SUBJECTED TO A HIGH RELATIVE HUMIDITY TO PREVENT ACID CRYSTALLIZATION
REELING & LACING
YARN IS UNWOUND FROM CAKE ONTO REELS - PRODUCING SKEINS
WASHING
TO ELIMINATE ACID
DRYING
DESULPHURING, WASHING, BLEACHING, SOURING, & WASHING
CENTRIFUGE HYDRO-EXTRACTING
DRYING & CONDITIONING
SKEINS ARE DRIED AND BROUGHT TO CORRECT MOISTURE CONTENT
SORTING & GRADING
WARPING & QUILLING
YARN IS PLACED IN FORM READY FOR USER

Step 15—Grading and Sorting. It is difficult to say which of the main objectives of this process are most important. It is obvious that inferior product must be eliminated and, yet, it is of vast importance that the manufacturer shall ship yarn with the established allowable regain. Not only should the seller sell the number of pounds of water he is entitled to sell, but also the buyer should demand a yarn having the right regain and realize that he is saving the money spent for pounds of water in so doing.

While the health of the worker and the needs of process have important consideration in the preceding processes, the comfort and efficiency of the worker becomes an important factor in this one. In this process, there is relatively little machinery and a relatively great number of employees.

The room and the air in it must be clean, for any dirt accumulating upon the product detracts from its quality. The hands of the operator must be reasonably free from perspiration and, therefore, the conditions maintained must satisfy the needs of comfort as well as the needs of product regain. A dry bulb of 80 F and a relative humidity of 55 per cent are entirely satisfactory, although experience in the loading of time fuses for shrapnel has indicated that 75 F and 50 per cent are necessary to afford perfect freedom from perspiration. A condition of 80 F and 55 or 60 per cent is looked upon as a practical compromise.

The air conditioning equipment must have a high cleaning efficiency and the system must embody all of the functions of year-round conditioning. If a large volume of moderately cold water is available, dehydrating equipment becomes attractive as a possible substitute for refrigeration.

Step 16—Warping, Winding and Quilling (Processing). Warping consists of winding many hundred yarns parallel upon a large spool called a beam. These parallel yarns form lengthwise threads of the woven fabric or what is commonly called the warp.

Hundreds of spools of rayon are placed on creels or racks, and each spool contributes its almost endless thread to the beam. If any one of these threads breaks, the machine is automatically stopped and the thread is

tied by hand. Every thread must remain perfectly aligned, since a high speed shuttle containing the quill or filler must pass in and out of this network after it is placed on the loom for weaving.

After the warp is completed, it is sized, so that the humidity in the weave room itself does not have the pronounced effect that it does in the room where the warp is made.

In winding the quill, the yarn is first wound from the skein to a spool and then on to the quill or cop or bobbin, as it is sometimes called. A twisting operation is introduced at this point. Efforts to wind direct from skein to quill have not been entirely successful.

In the early days of rayon, the concept of the manufacturer was that of producing and selling in the skein. Since rayon was a new product, having properties quite different from the natural silk, cotton and wool with which weavers and other processors were familiar, the manner of handling the new product resulted in its discredit in many instances in which it was not at fault. The first attack of the rayon manufacturer upon this problem was a pilot plant or laboratory in which the user's processes could be experimented with, the cause of troubles ascertained, and proof given that the synthetic yarn was not at fault. While this was a step forward, there were certain difficulties inherent to it and complete success was not to be had until the manufacturer of rayon determined to, and did, enlarge his process to include the final warping and quilling of his product under controlled conditions.

The important consideration of warping and quilling is that the stretch or extensibility of rayon is dependent upon regain which, in turn, is mainly dependent upon relative humidity. Rayon has a definite elastic limit and if stretched beyond that point will not return to its original length. If stretched beyond this elastic limit, it will, when woven with properly warped or quilled rayon, show up as a "shiner" or "cockle" or streak in the finished product. The importance of avoiding "shiners" will be fully realized when it is understood that the defect cannot be detected until it appears in the finished cloth.

Purposes of air conditioning in textile plants devoted to the manufacture of synthetic yarns are:

1. **Controlling the rate and extent of chemical reaction.**
2. **Protecting the worker from harmful byproducts of the process.**
3. **Fixing the regain, and hence certain physical properties of the product.**
4. **Improving the efficiency and health of the worker.**

The critical relative humidity is 62 per cent. For any humidity below that, stretch is proportional to strain. Beyond the critical point, however, stretch increases very rapidly.

Thus, warping and quilling require a relative humidity lower than 62 per cent; 55 per cent is satisfactory. Since the yarn contracts with loss of regain, the beams, quills, etc., must be prevented from drying out or else contraction may stretch beamed or quilled yarn beyond its elastic limit and cause "shiners."

Best results are obtained with year 'round air conditioning holding 80 F and 55 per cent.

Staple Fiber. A fairly recent and quite important addition to rayon products is the staple fiber of which a very considerable quantity is now being produced. This is produced by spinning a yarn of from 1000 to 1500 filaments which, following the necessary washing and other wet processes, is cut into uniform staple of any desired length. After being bleached and dried, it is baled, like cotton, and shipped to the spinner, who may spin it into a pure rayon thread or mix it with any of the commonly used textiles. The spun yarn has a characteristic appearance which is different from that of the skein and this characteristic may be altered in many ways by dilution with other fibers.

Acetate or Celanese Process

Unlike the other cellulose silks, acetate silk is an ester of cellulose (acetate of cellulose). In general, cellulose acetate is prepared by treating wood pulp or cotton with acetic acid anhydride in the presence of a suitable catalyst, precipitating and redissolving in a solvent such as chloroform, acetic acid, or acetone. The coagulating bath is either warm air, water, alcohol or benzene, depending upon the solvent used.

The output of acetate rayon is rapidly approaching that of viscose. Production by this method has the advantage in that the threads are spun ready to process—wind, warp or quill—with no further treatment such as is required by the other processes. Further, it results in a silkier product and makes possible the production of threads of finer deniers.

Briefly, the process is as follows:

1. The raw material (cotton linters) is treated with acetic anhydride, glacial acetic acid and a catalyst (usually sulphuric acid), which forms the cellulose acetate. This dissolves in the reaction mixture. This acetylation is performed in enamel lined tanks which are jacketed to control the temperature of the contents. This step requires very careful control to enable the production of an acetate of constant properties, *i. e.*, viscosity and acetic content, etc.
2. The tri-acetate, thus formed, is then hydrolyzed under careful control with the splitting off of the acetic acid until an approximate di-acetate is obtained.
3. This di-acetate of cellulose is re-precipitated as a white flocculent mass when the fluid is poured into water.
4. After a thorough washing, it is dried and dissolved in acetone to form the spinning liquor or "dope" as it is called, of the proper viscosity, which is filtered and stored in large tanks.
5. Under suitable pressure, the solution is forced through the fine orifices in the spinneret in a downward vertical direction. The metal cap is enclosed in a tube in which a current of warm air travels upward. The filaments are set by the evaporation of the acetone. This is called "dry" spinning as compared to the "wet" spinning of the viscose process. At the bottom of this tube the filaments are gathered and wound on a revolving bobbin. The air supplied to these tubes to absorb the acetone must have a low dew point to give around 25 per cent relative humidity. A negative pressure must be maintained so that any filtration of air will be inward (the acetone is valuable). The air temperature and quantity depends upon the design of the spinning frame.
6. The threads are twisted and then formed into warps, quills,

bobbins, etc., requiring a relative humidity of from 65 to 70 per cent.

The air conditioning problems presented by this process are quite similar to those of the viscose process. Up to spinning, the rates and limits of chemical reactions must be controlled by the regulation of temperature almost without regard to relative humidity. Acetic acid fumes must likewise be kept under control to guard the health of the employee.

Since the solvent is much more expensive than the textile which it "carries," solvent recovery is an economic essential. Solvent recovery, however, must be coordinated with air conditioning for minimum overall costs. Two systems are practical for acetone: Adsorption by activated carbon and solution in cold water. The latter is a continuous process and fits perfectly with spinning room requirements for air of low dew point. As in the viscose processes, maximum reliability of equipment is a prime requisite.

Weaving and Other Uses of Yarns

All of the other uses to which synthetic yarns can be put are too numerous to mention but, in general, will be found to require close to the same conditions required for weaving. As in weaving, consideration must be given to combination with other textiles which react differently to the same humidity.

In general, the relative humidity which may be carried will depend upon whether the fabric being processed is made of pure rayon or a mixture of rayon and some other textile—and depending likewise upon the extent to which the strength of that other textile can be made to combine with rayon. Relative humidity also depends upon the stress to which pure rayon is subjected. This applies with greater force to regenerated cellulose yarns than to other synthetic yarns which have a different strength characteristic. The conditions optimum for weaving pure rayon are modified to some extent by the protective sizing which is applied to the warp. The warp is subjected to much greater strain than the filler and the protective sizing alters its regain characteristic so that higher relative humidities are permissible.

In weaving pure rayon with well sized warp, a relative humidity of 65 per cent (3 per cent above the critical point) has proved satisfactory. One important factor in influencing this selection is that of comfort for the employees. Year 'round air conditioning (to which refrigeration is essential) is not economically practical because of the large internal heat gain for the average weave room and the comfort conditions which can be maintained with evaporative cooling improve as the relative humidity is raised. The 65 per cent which is optimum is therefore something of a compromise between a number of factors in which some little strength of product is sacrificed for the sake of better conditions for the employee.

In weaving or knitting pure acetate, relative humidities of 70 or 75 per cent are optimum because the critical strength or extensibility of that yarn is considerably higher than that of viscose yarn.

As previously stated, in weaving mixtures of synthetic and natural textiles, the coarser textile may act as a reinforcing agent for the weaker one. Depending upon the roughness of treatment, there is wisdom in compromise between the needs of the two textiles. The speed of looms has been increased to such an extent that common practice requires the maintenance of from 80 to 85 per cent relative humidity in weaving cotton, which is obviously much too high for viscose and somewhat high for acetate. Optimum relative humidities will vary from 60 to 70 per cent for cotton and viscose and 65 to 75 per cent for cotton and acetate, but holding a constant relative humidity is of greater importance than the exact humidity selected.

The problem again assumes an entirely different aspect when dealing with yarns that are spun from a mixture of staple rayon fiber and some other textile. In such instances, the relative portions of the weaker and stronger fibers may be such that conditions well above the optimum for the rayon may be carried and entirely satisfactory results obtained.

A most important consideration, however, in all mixtures is the difference in the normal strainless stretch of the two yarns as they react to different relative humidities. Ideal conditions are obviously those which will properly average the changes in length which the fibers will undergo throughout the range of conditions to which they will be subjected in normal use.

Entirely aside from the effect of relative humidity upon the product itself in weaving is its effect upon loom harness, which has much to do with loom efficiency and the quality and uniformity of the product.

[*Concluded*]

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60 TONS OF FANS

Photo Courtesy Buffalo Forge Co.

Six of the fans that will supply and exhaust air from the New Lincoln Vehicular Tunnel under the Hudson River at 39th St., New York City, ready for shipment. Each weighs approximately ten tons.

The 17 supply fans will handle a total of 3,218,000 cfm of air; at a density of 0.08 lb per cu ft this equals 370,000,000 lb or 185,000 tons per day—enough air for 10,600,000 people for one day at 35 lb per person.

The 19 exhaust fans will handle a total of 3,088,400 cfm which, at a density of 0.0784 lb per cu ft, equals 350,000,000 lb or 175,000 tons per day. Enough to take the breath away from 10,000,000 people.

Formulas for
Stresses in Bolted Flanged Connections

By E. O. Waters*, D. B. Wesstrom**, D. B. Rossheim†, and F. S. G. Williams††

Progress in pressure vessel design and fabrication during the past two decades has brought about a marked change in the form of bolted connections. Whereas flanges were formerly provided with hubs of approximately uniform thickness, screwed to or slipped over the shell or pipe, it is now customary to use tapered hubs, and an integral structure is obtained by butt welding the end of the hub to the shell. This has invalidated former methods of design for flanged connections. . . . . This paper outlines a revised analysis based on the ring, tapered hub, and shell being considered as three elastically coupled units loaded by a bolting moment, a hydrostatic pressure, or a combination of the two. Design formulas and charts are given for the computation of stresses that are likely to be critical, and their application is illustrated by three problems which are taken from current commercial practice.

THE analysis of stress distribution for a tapered hub flange, the assumptions for which were given in the first part of this paper published last month, is continued in the following paragraphs.

The following nomenclature is used throughout; in addition, the design formulas employ a notation, explained later, wherein the effort has been made to retain correspondence with present boiler code usage, as far as possible. In Fig. 3, where many of these symbols are indicated, it should be noted that forces and moments are shown in the direction which is taken as positive in this paper.

Nomenclature

A = outside diameter of ring, in.
a = lever arm, which when multiplied by the total bolt load W gives the total moment loading on the ring, in.
B = inside diameter of ring, hub, and shell, in.
c_n = constant of integration
D = flexural modulus of ring $= \dfrac{Et^3}{12(1-\nu^2)}$, in.-lb
E = Young's modulus, lb per sq in.
g_0 = shell thickness, in.
g_1 = maximum hub thickness, in.
g = intermediate hub thickness, in.
h = hub length, in.
$K = A/B$
M_h = moment on a unit sector of hub, at any point, lb. Subscripts 0 and 1 refer to this moment at the small and large ends of the hub, respectively
M_r = radial moment at any cylindrical section of the ring, per unit circumference of the section, lb. Subscripts 1 and 2 refer to this moment at the inside and outside diameters of the ring, respectively
M_t = tangential moment at any point on a radial section of the ring per unit radius, lb. Subscripts 1 and 2 same as for M_r
P = shear on a unit sector of hub, at any point, lb per in. Subscripts 0 and 1 same as for M_h
p = hydrostatic pressure, lb per sq in.
Q = shear on a cylindrical section of the ring, per unit circumference of the section, lb per in.
r_1 = inside radius of ring, hub, and shell, in.
r_2 = outside radius of ring, in.
r = radius to any point in ring, in.
t = ring thickness, in.
W = total bolt load, lb
W_1 = equivalent bolt load, or total force applied at the outside diameter of the ring, and (oppositely) at the inside diameter of the ring, which multiplied by the radial breadth of the ring equals the total moment loading on the ring, lb
w = nondimensional radial displacement of hub or shell at any point, $= y/r_1$
x = axial distance along hub or shell, measured from junction surface between them, and positively in direction toward ring, in.
y = radial displacement of hub or shell at any point, in. (positive away from axis)
z = axial displacement of ring at any radius, in. (positive toward hub)
α = taper factor for hub $= (g_1 - g_0)/g_0$
β = shell modulus $= \sqrt[4]{3(1-\nu^2)/r_1^2 g_0^2}$
θ = rotation of element of junction surface between hub and ring
κ = hub modulus $= 12(1-\nu^2)\,h^4/r_1^2 g_0^3$
ν = Poisson's ratio; assumed value in design formulas is 0.3
ξ = nondimensional axial distance along hub $= x/h$

Tapered Hub Flange Without Hydrostatic Pressure

The loading and dimensions for the ring are indicated in Fig. 3. According to the Poisson-Kirchoff theory, the deflection of a flat plate with axial symmetry and no distributed load is given in polar coordinates by

$$\left(\frac{d^2}{dr^2} + \frac{1}{r}\frac{d}{dr}\right)\left(\frac{d^2}{dr^2} + \frac{1}{r}\frac{d}{dr}\right) z = 0 \quad \ldots\ldots\ldots\ldots [1]$$

By solving this equation and differentiating the expression for z the appropriate number of times, equations for M_r, M_t, and Q are obtained. The complete solution obviously has four integration constants; only three

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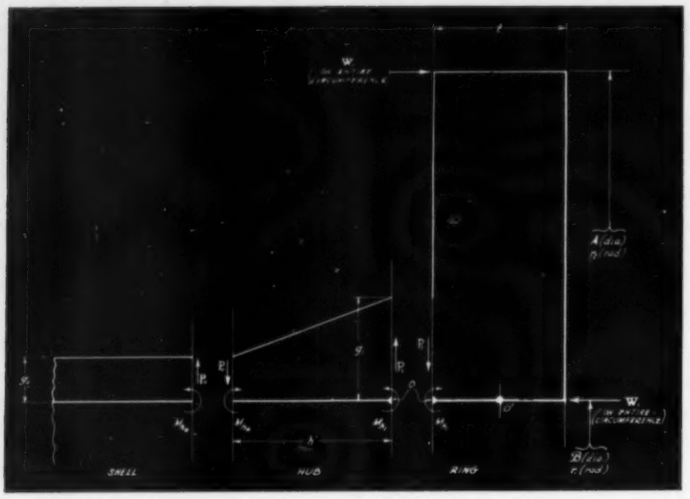


Fig. 3—Analysis of forces and moments in a tapered hub flange

boundary conditions are known so that, to eliminate all four constants, it is necessary to express a relation between two elastic conditions determined by the solution of Equation [1]. The most convenient relation, in so far as the subsequent analysis is concerned, is between M_{r1} and θ; it may be expressed by the equation.

$$M_{r1} = -\frac{K^2-1}{\frac{1+\nu}{1-\nu}K^2+1}\left((1+\nu)\frac{2D}{B}\theta + \frac{W_1}{2\pi}\left[\frac{1}{2}+\frac{(1+\nu)}{(1-\nu)}\frac{(K^2)}{(K^2-1)}\log_e K\right]\right) \quad \ldots\ldots[2]$$

Also

$$M_{t1} = -\frac{K^2+1}{K^2-1}M_{r1} - \frac{W_1}{2\pi}\left[\frac{1-\nu}{2}+\frac{(1+\nu)K^2}{K^2-1}\log_e K\right] \quad \ldots[2a]$$

The three known boundary conditions which serve in the derivation of Equation [2] are

$$\left.\begin{aligned} z_1 &= 0 \\ M_{r2} &= 0 \\ Q &= -W_1/2\pi r \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots[3]$$

The hub loading is also shown in Fig. 3. The stresses and deformations are the same as those for a beam with varying section on an elastic foundation, if we consider a strip of the hub having unit circumferential dimension. Whether this dimension be measured at the middle, inside or outside surface is relatively unimportant; in this discussion, to preserve conformity with the ring analysis, the measurement is taken at the inside surface. Then the radial displacement at any point is given by

$$\frac{d^2}{dx^2}\left(g^3\frac{d^2y}{dx^2}\right)+\frac{12(1-\nu^2)g}{r_1^2}y = 0 \quad \ldots\ldots\ldots[4]$$

For convenience, this may be written in nondimensional form as

$$\frac{d^2}{d\xi^2}\left[(1+\alpha\xi)^3\frac{d^2w}{d\xi^2}\right]+\kappa(1+\alpha\xi)w = 0 \quad \ldots\ldots\ldots[4a]$$

by the substitutions defined in the nomenclature. It should be noted that the ratio $h^4/r_1^2g_0^2$, which is the essential part of κ, plays, with α, the most important rôle in the strength of the hub.

When g is variable, an exact solution is obtainable in terms of Bessel functions (9)*. In the present development, a close approximation is obtained by the strain-energy method with three parameters (a_1, a_2, a_3) which are so related that, if a_1 is used alone, a first approximation is obtained and all boundary conditions are satisfied; if a_1 and a_2 are used, a second approximation is obtained with all boundary conditions satisfied; and similarly for a_1, a_2, and a_3, used together (10). With regard to the boundary conditions, it may be remarked that here again they are four in number, since we are dealing with a fourth-order equation. They may be taken as: The radial displacement at the large end, moment at the large end, moment at the small end, and shear at the small end, in which cases the first is known (zero) and the remaining three are, for the present, unknown. In harmony with the nondimensional notation used in Equation [4a], these three unknown conditions may be replaced by the three quantities A_0, A_1, and B_0, which represent respectively the dimensionless curvature $d^2w/d\xi^2$ at the small end of the hub, that at the large end of the hub, and the dimensionless curvature gradient at the small end of the hub. Then, as explained in the authors' complete report (8), w can be written as a polynomial in powers of ξ, with a_1, a_2, a_3, A_0, A_1, and B_0 appearing in the coefficients; and equations can be found which determine a_1, a_2, and a_3 in terms of A_0, A_1, and B_0 for any given κ and α (i.e., any given hub proportions) and make the total energy of the strained hub, with its loads, a minimum. Coincidentally, Equation [4a] is approximately satisfied. This step is tantamount to solving Equation [4a] for w in terms of three unknown constants of integration, the fourth being zero ($w_1 = 0$). From the result, it is possible to compute slopes, moments, and shears by successive differentiation.

The shell has constant thickness g_0 and extends indefinitely from the hub. Using the same elastic theory as for the hub, two of the constants of integration vanish, and

$$y = e^{\beta x}(c_3 \sin \beta x + c_4 \cos \beta x) \quad \ldots\ldots\ldots[5]$$

where $\beta = \frac{\sqrt[4]{\kappa/4}}{h}$, and x, it must be remembered, is now negative. Here again, the elastic conditions of higher order, such as slope and moment, are obtained by successive differentiation.

The analysis of the three separate parts of the flange is now complete, but there are five unknown constants in the equations, and these must either be evaluated or eliminated before numerical results can be obtained that will be consistent for the flange as a whole. On opposite sides of the shell-hub interface, the displacements, slopes, moments and shears are mutually identical; therefore, four equations exist whereby c_3, c_4, A_0, and B_0 may be expressed in terms of A_1. Having taken this step, it is then possible to express the slope θ, moment M_{h1} and shear P_1 at the large end of the hub, in terms solely of A_1. Finally, since $M_{h1} - 1/2P_{1t} = M_{r1}$, the quantities

*Numbers in parentheses refer to bibliography at end of article.

θ, M_{h1} and P_1 may all be substituted in Equation [2] and the latter then solved for A_1, giving the equation

$$A_1 = -\frac{2(1-\nu^2)\,h^2}{Eg_1^2 r_1} MX \quad \ldots\ldots\ldots\ldots\ldots\ldots [6]$$

where M and X are defined following Equation [10]. The resulting relation is the key to the derivation of the design formulas which are presented in a later paragraph.

The mathematical articulation of the three parts of the flange, as just outlined, involves an excessively large amount of computation whenever a numerical problem is to be solved. However, by grouping all terms in the final formula for A_1 which contain the parameters a_1, a_2, a_3, and constants A_0 and B_0 into two factors F and V, the first of which is proportional to P_1/A_1 and the second to θ/A_1, and plotting curves of F and V with α and κ (or their equivalents in hub dimensions) as arguments, a moderate amount of systematic computation in the preparation of the charts is substituted for many hours of labor on individual, unrelated design problems. The F and V factors appear in the design formulas, and are plotted in Figs. 4 and 5. In one case they apply to the integral type of flange that has just been analyzed; in the other, they are for loose flanges, where $A_0 = B_0 = 0$. In either event, they include the case of the uniform-hub-thickness flange, where $\alpha = 0$.

With regard to the shear force P_1 which enters into the determination of A_1, it should be noted that, theoretically at least, it can be determined either by differentiating w three times or integrating it once. Actually, due to the approximate nature of the strain-energy method, the two results are never identical. It is reasonable to suppose, however, that a single integration would introduce a smaller error than three successive differentiations, and comparison of numerical solutions by the precise and strain-energy methods bears out this assumption. The authors have accordingly used the following expression for P_1 in the detailed mathematical development:

$$P_1 = \frac{E}{r_1^2}\int_0^h gy\,dx + P_0 \quad \ldots\ldots\ldots\ldots\ldots\ldots [7]$$

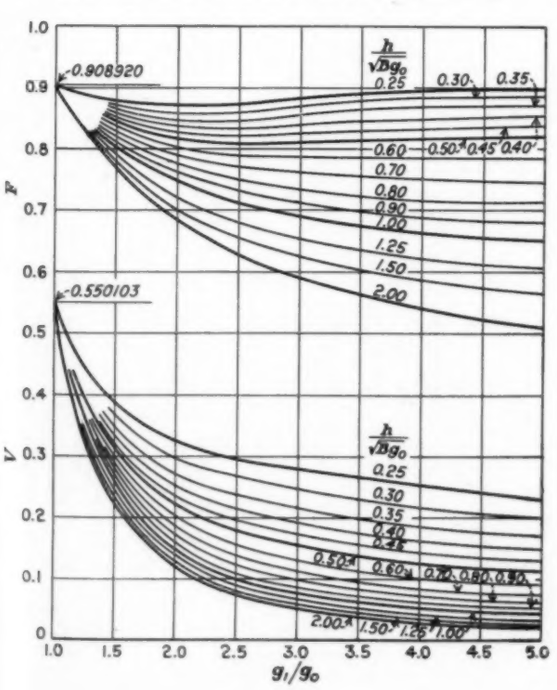


Fig. 4—Values of F and V for an integral flange

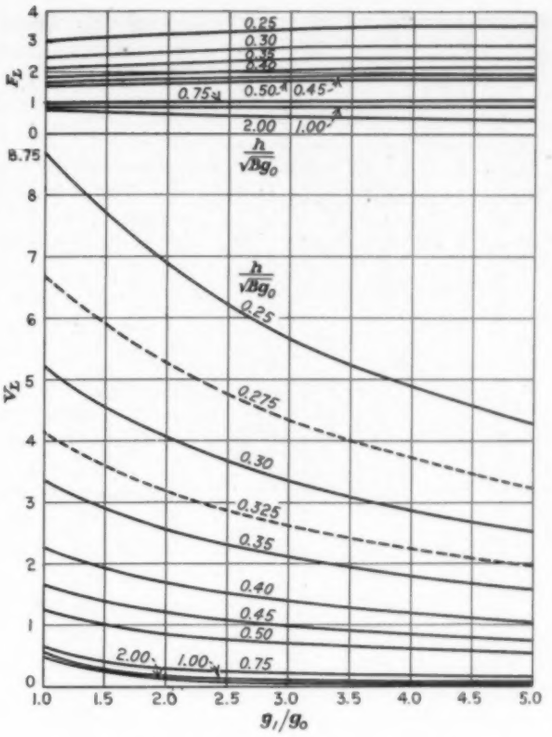


Fig. 5—Values of F and V for a loose flange
(Subscript L denotes values of F and V are for a loose flange.)

Development of Design Formulas

For design and inspection purposes, a detailed analysis of the elastic conditions in all parts of the flange is superfluous, and the requisite data for information and guidance should be consolidated into a few usable formulas for stresses that may possibly be critical. Such formulas would be expected to cover conventional practice, or conservative extensions beyond present conventional design, but always with the reservation that new designs of more radical proportions might possess critical sections that would only come to light through the detailed analysis. All evidence indicates that for a flange with straight hub, the critical stresses are the radial and hoop stresses at the inside diameter of the ring, and the axial hub stress at the surface of junction with the ring. When the hub tapers in the manner assumed in this paper, the same critical stresses may be expected with the exception that, when the angle of taper increases beyond a certain limit, relative to the other hub proportions, the hub becomes so much more rigid than the shell that the location of the critical axial stress in the hub may be displaced from the large toward the small end or even into the shell. The question of the location and magnitude of this critical stress is of the first importance, and a careful study of stress distribution was made for the entire range of hub proportions covered in the charts for F and V, shown in Figs. 4 and 5, to determine under

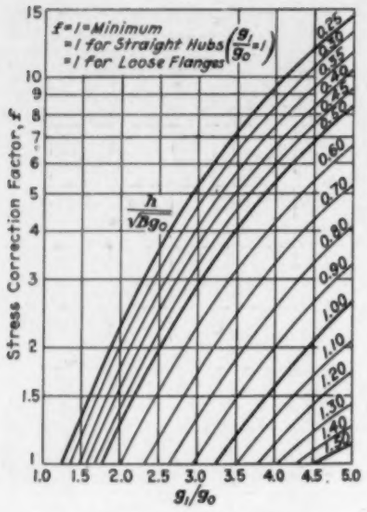


Fig. 6—Values of stress correction factor f

what circumstances a correction factor should be applied to the stress at the large end of the hub, so as to obtain the true maximum stress. It was found that the maximum axial stress always occurred either at one end of the hub or the other; consequently, it is a simple matter to compute its value by using, for the hub moment, either M_{h1} or M_{h0}, according to the location of the critical section. This has been done in design formula [8], where the factor f has been introduced to make the appropriate correction, if any, in the stress. One exceptional condition arises: When α and κ are such that the bending stresses at both ends of the hub are approximately equal, slight oscillations in the values of stress at points along the hub make f somewhat greater than unity. This has been taken account of, in preparing the chart for f shown in Fig. 6, by an adjustment of the lower end of the curves in the vicinity of $f = 1$.

In the case of loose flanges, an investigation of hubs over the ranges of proportions considered in this paper brought out the fact that the maximum bending stress always occurs at the large end of the hub, consequently $f = 1$ for loose flanges.

In accordance with the foregoing principle, three design formulas have been derived from Equation [6] for computing the maximum axial stress in the hub (or shell), the radial stress in the ring at its inside diameter, and the corresponding hoop or tangential stress. The first of these results directly from substitution of Equation [6] in

$$M_{h1} = \left[\frac{EI}{12(1-\nu^2)} \frac{d^2y}{dx^2} \right]_1 = \frac{Eg_1^3 r_1 A_1}{12(1-\nu^2)h^2}$$

dividing by the section modulus $g_1^2/6$ according to the simple flexure theory, and multiplying by the factor f, which is the ratio of the maximum axial bending stress to the axial bending stress at the junction of the hub and ring. The second results from substitution of M_{h1} and P_1 in the equation $M_{r1} = M_{h1} - \frac{1}{2} P_1 t$, followed by the usual conversion from moment to extreme fiber stress, to which is added the radial stress due to the shear P_1 assumed to be uniformly distributed through the ring thickness. The third is obtained exactly as the second with the added use of Equation [2a]. In this third formula, the hoop stress due to P_1 is added. Finally, it is assumed that $\nu = 0.3$ and the logarithmic base is changed from e to 10 to facilitate slide-rule computation. Then, using the special design notation, these stresses are

$$S_H = fMX/g_1^2 \quad [8]$$

$$S_R = \left[1 + 1.33F \frac{t/g_0}{\sqrt{B/g_0}} \right] MX/t_2 \quad [9]$$

$$S_T = (MY/t^2) - ZS_R \quad [10]$$

where S_H = maximum axial stress at outer surface of hub or shell, lb per sq in.
S_R = radial stress at the inside diameter of the ring, in ring face next to hub, lb per sq in.
S_T = hoop stress coincident with S_R, lb per sq in.
$M = Wa/B$
f = ratio of S_H to axial stress at outer surface of hub where hub joins flange = stress-correction factor. Values are plotted in Fig. 6 for g_1/g_0 from 1 to 5, and $h/\sqrt{(Bg_0)}$ from 0.25 to 1.50
F, V = plotted in Figs. 4 and 5 for the same range as in Fig. 6

$$X = \frac{1}{\frac{1}{T}\left(1 + \frac{t/g_0}{\sqrt{B/g_0}} F\right) + \frac{V}{U} \frac{(t/g_0)^3}{\sqrt{B/g_0}}}$$

$$T = \frac{3K^2\left(1 + 2\frac{1+\nu}{1-\nu} \cdot 2.3026 \log_{10} K\right) - 3}{\pi(K-1)\left(1 + \frac{1+\nu}{1-\nu} K^2\right)}$$

$$U = \frac{3K^2\left(1 + 2\frac{1+\nu}{1-\nu} \cdot 2.3026 \log_{10} K\right) - 3}{\pi(1+\nu)(K^2-1)(K-1)}$$

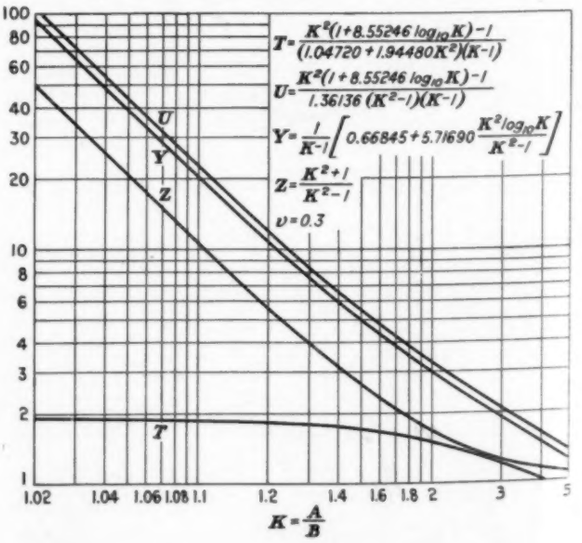
$$Y = \frac{1}{K-1}\left[\frac{3}{\pi}(1-\nu) + \frac{6}{\pi}(1+\nu)\frac{K^2}{K^2-1} 2.3026 \log_{10} K\right]$$

$$Z = \frac{K^2+1}{K^2-1}$$

Functions of K are plotted in Fig. 7. It should be noted that in the case of loose-ring flanges, there is no hub, consequently S_H and S_R as given by Equations [8] and [9] equal zero.

[*To be continued.*]

Fig. 7—Values of T, U, Y, and Z when $\nu = 0.3$



CONTROLS

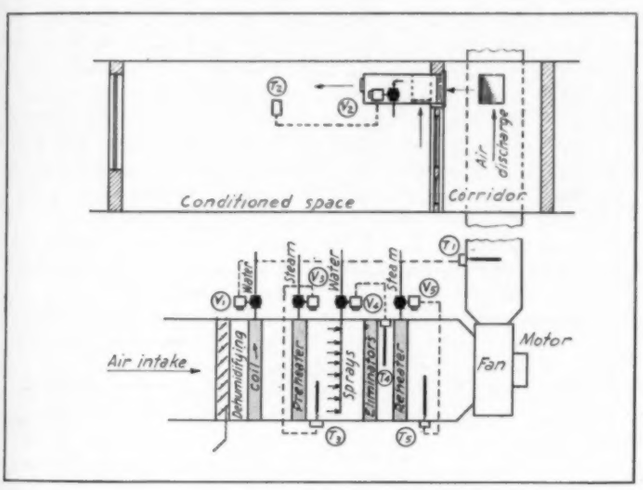
By C. L. Ringquist*

Reference Sheet 11

Zone Control Systems

The following system is designed for cooling, dehumidifying, ventilating, humidifying, and zone control. The central system handles outside air only. A unit is suspended in the room either close to the corridor wall with a grille through the corridor wall, or in the transom of the entrance door to the conditioned space.

This type of system lends itself to large office buildings where the corridors may be used for introducing the outside air into the various spaces without the necessity of furring down the ceilings or running large ducts.



Cycle—Where large volumes of outside air are to be introduced, it may be advisable to use a reheating cycle on the central fan system during summer operation. This can be accomplished by transferring some of the sensible heat in the incoming outside air to the leaving dehumidified air by means of two coils, one in the outside air intake and one in the central system after the dehumidifying coil. A small circulating pump and piping would interconnect these two coils, and the water would be circulated, thus transferring the sensible heat from the outside air to the dehumidified air leaving the fan from the central system.

The controls for the winter cycle include temperature controller T_3 after the preheating coil and before the sprays, controlling modulating motorized or diaphragm valve V_3 in the steam line to the preheating coil. This valve adjusts itself to supply exactly the right amount of steam to the preheating coil to maintain a constant entering air temperature to the sprays.

Temperature controller T_4 in the central air conditioning plant between the eliminators and the reheating coils controls the action of modulating valve V_4 in the water line to the sprays to maintain a constant temperature leaving the spray chamber and thus a constant humidity. Temperature controller T_5 in the central air conditioning plant after the reheating coil controls the action of modulating valve V_5 in the steam line to the reheating coil to maintain a constant temperature leaving this coil.

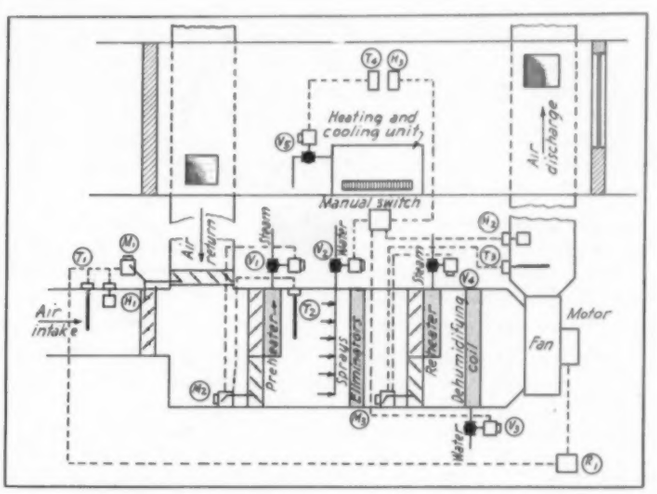
The controls for summer operation consist of temperature controller T_1 in the fan discharge, interconnected with modulating motorized or diaphragm valve V_1 in the refrigerant supply to the dehumidifying coil. T_1 acts to maintain a constant temperature leaving the fan discharge, and thus a constant humidity of the air entering the discharge duct work.

Room thermostat T_2 is of the summer-winter type and controls the sensible temperature only in summer by means of modulating valve V_2 in the supply line to the sensible cooling coil.

When water is used for cooling and dehumidifying, the same coils may be used in the set-up for winter operation by circulating hot water through them.

The operation of the fans in the room units is controlled manually and may be of the three speed type to give proper regulation and adjustment of the job when it is installed.

The following arrangement illustrates a type of system involving all the various functions, including heating, ventilating, dehumidifying, cooling, humidifying, and zone control. It employs a central system for dehumidifying, humidifying, and tempering the outside and some recirculated air, and a heating and cooling unit in each zone for taking care of the sensible cooling in summer and the sensible heating in winter. It embodies the feature of the possibility of taking in all outside air for cooling whenever the outside air is at such conditions that it may be so used.



Cycle—The control cycle for winter operation is made up of the following: A duct thermostat T_3 between the preheater coil and the spray chamber acts to modulate damper motor M_3 to pass more or less air through the preheater coil or through the bypass, as required, to maintain a constant air temperature entering the sprays. M_3 is equipped with an auxiliary switch controlling the action of motorized or diaphragm valve V_1 in the steam line to the preheater coil. This auxiliary contact closes the valve whenever all of the air is being bypassed around the preheater coil—that is, when the face dampers are closed. V_1 is of the two position type.

Duct humidistat H_2 in the fan discharge controls the operation of modulating motorized or diaphragm valve V_3 in the supply line to the sprays, and acts to maintain a constant relative humidity leaving the fan by modulating the amount of water supplied to the sprays.

Duct thermostat T_3 in the fan discharge is interconnected to modulating damper motor M_3, which acts to control the amount

*Air Conditioning Dept., The Trane Co.

of air passing through or around the reheater coil, thus maintaining a constant leaving air temperature from the fan. M_3 is equipped with an auxiliary contact which acts to shut off two position valve V_4 in the steam line whenever all of the air is being bypassed around the reheater coil.

Room thermostat T_4 controls the operation of modulating valve V_5 in the steam or hot water line to the heating unit. Relay R_1 acts to open the outside air damper by means of damper motor M_1 to a minimum position whenever the fan motor is started, and operates on both summer and winter cycles.

The controls for the summer cycle consist of a manual switch of the summer-winter type to throw the control from summer to winter cycle, or *vice versa.*

Duct thermostat T_1 and duct humidistat H_1 in the outside air intake are interconnected to damper motor M_1 so that whenever the outside air is at such a condition that it is possible to use it for cooling purposes, the return air damper is closed, and the outside air damper is opened to its maximum position. If for any reason the air then should change to such a condition that it is not possible to use it for cooling and dehumidifying, damper motor M_1 resumes its minimum setting in accordance with relay R_1, interconnected to the fan motor.

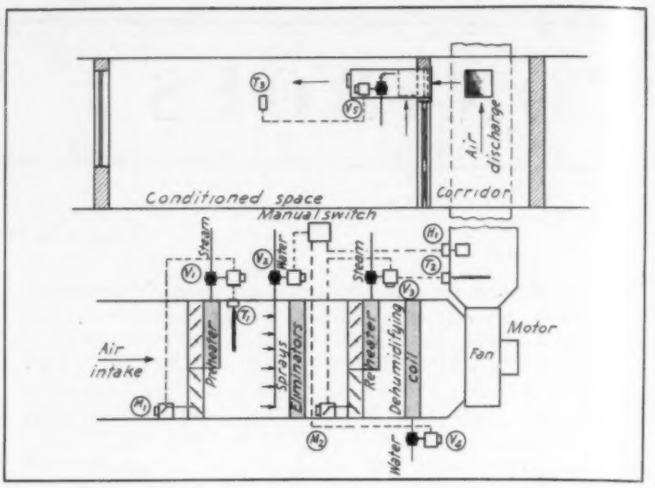
Room humidistat H_3 in the conditioned area is interconnected to the manual summer-winter switch and also to modulating valve V_3 in the refrigerant line to the dehumidifying coil. H_3 acts to modulate V_3 so that it is possible to supply more or less dehumidifying to the central fan system air.

Room thermostat T_4 of the summer-winter type, acts to control modulating valve V_5 in the refrigerant line to the cooling unit. It should be noted that it is more convenient to use chilled water for cooling and hot water for heating in this unit, as it is only necessary, then, to change over from summer to winter operation on the control cycle.

As an alternate on the summer control cycle, humidistat H_3 could control the operation of a damper in the grille in the discharge air duct to the conditioned space. H_3 would then govern the amount of dehumidified air supplied to the conditioned area and would close this damper until it reached a minimum setting upon falling humidity requirements. The minimum setting would be necessary in order that the proper amount of outside air could be supplied each area.

The next diagram illustrates another type of system employing all the equipment required for heating, ventilating, dehumidifying, cooling, humidifying and zone control. The central system in this case takes care of all of the outside air and does not withdraw any recirculated air from the conditioned space.

Cycle—The controls for the winter cycle consist of duct thermostat T_1 which acts to modulate damper motor M_1 and regulate the amount of air passing through the preheater coil and through the bypass in order to maintain a constant entering air temperature to the spray chamber. Damper motor M_1 is equipped with an auxiliary switch to close two position valve V_1 in the steam line to the preheating coil whenever the face damper over this coil is closed.



Duct humidistat H_1, interconnected to modulating motorized or diaphragm valve V_2 through the summer-winter switch, controls the leaving air at a definite humidity by modulating V_2 to supply more or less water to the sprays. Duct thermostat T_2 in the fan discharge controls the action of modulating damper motor M_2 to pass more or less air through the reheater coil and thus maintain a constant temperature of air leaving the fan discharge. M_2 is equipped with an auxiliary contact to close V_3 whenever the face damper over the reheater coil is closed.

Room thermostat T_5, of the summer-winter type, modulates motorized or diaphragm valve V_5 in the steam or hot water line to the room unit heating coil to supply more or less steam to the coil and maintain a constant room temperature. The summer-winter switch is of the manual type and reverts the controls from the summer or winter cycle.

The controls for the summer cycle consist of duct humidistat H_1, which is also used for the winter cycle, and which during the summer cycle controls the operation of modulating motorized or diaphragm valve V_4 in the refrigerant line to the dehumidifying coil, thus maintaining a constant relative humidity leaving the fan discharge. T_2 being of the summer-winter type, modulates motorized or diaphragm valve V_5 to supply the necessary cooling for sensible heat removal during the summer cycle.

The illustration shows the necessary controls for one zone only. However, additional zones may be added by the addition of the necessary room conditioning units, thermostats, and valves. The central system controls remain as shown.

In concluding this series of reference sheets, let it be said that it is possible to make a considerable number of variations of the control cycles. However, the control cycles described illustrate the ones most commonly used and those which employ the basic design of equipment and control.

Condensation on Pictures

In the *Journal* of the *Institution of Heating and Ventilating Engineers* (Vol. 5, No. 51), H. E. Beckett reports the results of work done at the Building Research Station in England on the condensation on unglazed pictures in picture galleries. From an inspection of pictures in a gallery it was concluded that the trouble arose on those occasions following a change from colder to milder weather, when air in the gallery was humid and the external walls comparatively cold. Under such conditions, the canvas of an unbacked picture loses heat to the cold wall behind it by radiation and may be cooled sufficiently for moisture to be deposited on its front surface. From the test results it was concluded that:

The difference of temperature between the air and the picture surface is not greatly affected by fixing the picture clear of the wall surface so as to ventilate the back of the canvas.

By providing a diaphragm of reinforced aluminium foil at the back of the canvas it is possible to reduce the cooling effect of the wall considerably. The picture is then maintained substantially at air temperature and the possibility of moisture condensing upon the surface is greatly reduced.

Selecting the Right Size Heating Boiler†

By Sabin Crocker*

Item 2—Computation of Load Due to Bare and Covered Piping

Boiler catalogs frequently recommend adding some flat percentage allowance to the equivalent nominal radiation to care for heat loss from bare and covered pipe in the supply and return lines. Such percentage allowances commonly are given as 25 per cent of the equivalent nominal radiation for steam systems and 35 per cent for hot water, although allowances as low as 10 and 15 per cent, respectively, have been suggested, presumably where the piping was covered. Use of a flat percentage allowance is preferable to ignoring entirely the load due to heat loss from the supply and return lines, but better practice, especially where there is much bare pipe, calls for an actual computation of the emission from both bare and covered pipe surface.

After computing the actual amount of bare pipe surface existing in any heating system, due allowance must be made for the large heat emission of this type of surface. For approximate results, the factors shown in Tables 1 and 2, on pp. 2 and 3, may be employed for conversion to a nominal radiation basis. Where more exact results are desired, the amount of surface of each size of bare pipe should be computed and the corresponding heat emissions figured from data such as that shown in Table 3.

Table 3 indicates that small pipes have considerably larger emissions per square foot than large pipes, which may have a decided effect on the total amount of heat emitted from the bare pipe surface. Data given are for horizontal pipes. The corresponding losses from vertical pipes are somewhat less, but in the absence of specific values may be assumed as the same. Where excessive bare pipe emission is indicated, it is advisable to cover enough of the pipe to reduce the emission to that required to heat the room to the desired temperature.

It should be noted that the heat loss of bare copper pipe, while somewhat less than for black iron or steel pipe, is still considerably greater than the loss from steel pipe with only ½ in. of insulation. The loss from bare copper pipe depends on the degree to which pipe has tarnished so that new copper pipe will transmit much less heat than old tarnished pipe. If lacquer is applied to copper pipe, the heat transmitting properties are increased to practically the same as for black iron or steel pipe. When copper pipe is insulated, the lower radiating effect of the copper surface is eliminated and the loss through the insulation is the same as when applied to iron or steel pipe of the same dimensions.

Heat loss from insulated pipes also should be taken into account in computing boiler loads. Where ¾ in. thick insulation is used, the heat loss can be assumed as approximately 25 per cent of that from the same size of bare pipe under the given conditions for fluid and air temperature. Where covering of greater or less thickness than ¾ in. is used, reference may be made to Fig. 1 on p. 4 giving heat transfer coefficients for bare pipe and for various thicknesses of covering on the different nominal pipe sizes.

---

*Engineer, The Detroit Edison Co. Member of Board of Consulting and Contributing Editors.

†Summarized and revised from a series of three articles published in Heating, Piping and Air Conditioning, February-March-April, 1932.

Footnotes, Table 3

[a]Based on experimental data obtained at the Mellon Institute.

[b]An average heat emission with steam at 215 F and air at 70 F is 360 Btu per sq ft per hr and for hot water at 170 F and air at 70 F, 225 Btu per sq ft per hr.

[c]Conversion to other conditions of fluid or air temperatures may be accomplished by use of the following formula: $H = Hs[(tf\text{-}ta)/(215\text{-}70)]^{1.28}$ where H = heat emitted under desired conditions, tf and ta = corresponding fluid and air temperatures respectively, Hs = heat emitted with fluid temperature of 215 F in air at 70 F. Conversion factors given in Table 2 and computed from the similar formula $H = Hs[(tf\text{-}ta)/(215\text{-}70)]^{1.3}$ will produce results sufficiently accurate for most practical applications.

Here is the second installment of a new series of "summary sheets," on this and the preceding page. The purpose of these sheets is to make available for quick reference for everyday use information needed in heating, piping and air conditioning work. . . . For complete information, refer to the original article from which these data were obtained, as the purpose of these summaries is not to take the place of the article, but rather to put the essentials into convenient reference form. . . . The Editors will appreciate your suggesting what type of material you'd like presented in this way. . . . Address HEATING, PIPING AND AIR CONDITIONING, 6 North Michigan Avenue, Chicago, Ill.

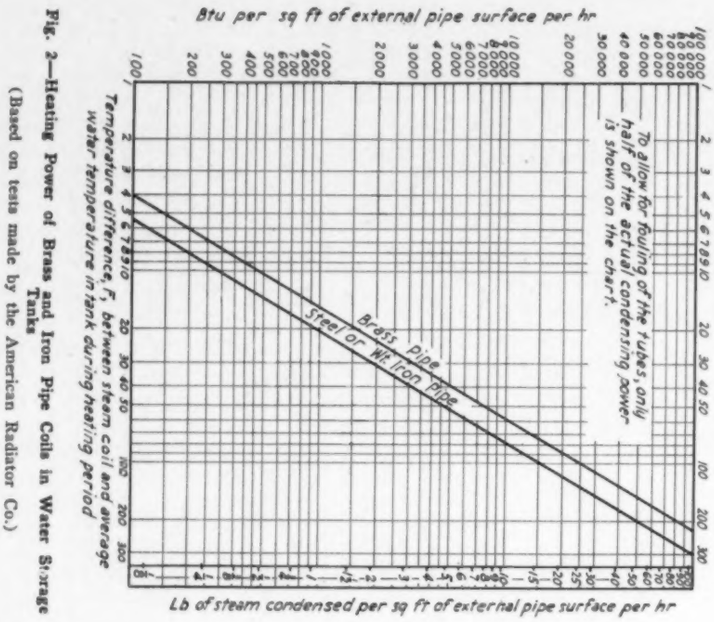

Btu per sq ft of external pipe surface per hr
Temperature difference, F, between steam coil and average water temperature in tank during heating period
Brass Pipe
Steel or Wt Iron Pipe
To allow for fouling of the tubes, only half of the actual condensing power is shown on the chart.
Lb of steam condensed per sq ft of external pipe surface per hr

Fig. 2—Heating Power of Brass and Iron Pipe Coils in Water Storage Tanks

(Based on tests made by the American Radiator Co.)

It should be understood that the 25 per cent heat loss assumption is an approximation representing a compromise figure for different pipe sizes. Actually, a given thickness of covering is much less efficient on a small pipe than on a large one due to relatively greater increases in outer surface exposed to the air. This is compensated for in part if the heat loss from covered pipe is taken as 25 per cent of the bare pipe losses proportioned to nominal pipe diameter as indicated in Table 2. Where a more accurate figure is required, the loss through the corresponding thickness of insulation can be computed for the amount of pipe of each size in the system, using values from the curves of Fig. 1. According to the *A. S. H. V. E.* code,[1] pipe covering less than ¾ in. should be considered the same as bare pipe in computing boiler load, while pipe covering ¾ in. or more in thickness is considered as having 25 per cent the heat loss of bare pipe. This is a rather rough approximation and the computation of heat loss in any given instance can be refined as much as circumstances seem to dictate.

[1] "Code for Rating Steam Heating Solid Fuel Boilers."

Table 3—Heat Emission from Horizontal Bare Iron or Steel Pipes in Air at 70 F

Nominal Pipe Size	External Surface: Linear Ft Per Sq Ft Surface	External Surface: Sq Ft Surface Per Linear Ft	Heat Emission[a] Btu Per Linear Ft Per Hr Per F: Steam 215 F	Heat Emission[a] Btu Per Linear Ft Per Hr Per F: Hot Water 170 F	Total Heat Emission[b] Btu Per Sq Ft Per Hr: Steam[c] 215 F	Total Heat Emission[b] Btu Per Sq Ft Per Hr: Hot Water 170 F	Equivalent Sq Ft of Column or Tube Radiation with Steam at 215 F: Steam 240 Btu	Equivalent Sq Ft of Column or Tube Radiation with Steam at 215 F: Hot Water 150 Btu	Equivalent Sq Ft of Column or Tube Radiation with Hot Water at 170 F: Steam 240 Btu	Equivalent Sq Ft of Column or Tube Radiation with Hot Water at 170 F: Hot Water 150 Btu	Condensation Factor, Lb Per Hr Per Sq Ft Steam at 215 F
½	4.547	0.220	0.643	0.594	425	270	1.76	2.82	1.13	1.80	0.441
¾	3.637	0.275	0.770	0.716	407	259	1.68	2.68	1.09	1.74	0.418
1	2.904	0.344	0.929	0.862	391	249	1.61	2.58	1.04	1.67	0.403
1¼	2.301	0.435	1.16	1.065	387	246	1.60	2.56	1.02	1.63	0.400
1½	2.010	0.498	1.30	1.197	379	241	1.57	2.51	1.00	1.60	0.392
2	1.608	0.622	1.58	1.461	368	234	1.53	2.45	0.98	1.57	0.383
2½	1.328	0.753	1.89	1.742	363	231	1.50	2.40	0.96	1.54	0.375
3	1.091	0.917	2.26	2.063	358	226	1.46	2.34	0.94	1.50	0.366
3½	0.954	1.047	2.53	2.333	350	223	1.45	2.31	0.92	1.48	0.362
4	0.848	1.178	2.81	2.600	346	220	1.43	2.28	0.92	1.47	0.356
5	0.686	1.456	3.41	3.140	340	216	1.40	2.24	0.90	1.44	0.350
6	0.576	1.734	4.05	3.703	338	213	1.40	2.24	0.89	1.42	0.349
8	0.443	2.257	5.19	4.720	334	209	1.39	2.23	0.87	1.39	0.348
10	0.355	2.817	6.38	5.820	329	207	1.37	2.19	0.86	1.38	0.343
12	0.299	3.338	7.53	6.870	327	206	1.36	2.18	0.86	1.37	0.340
18	0.212	4.717	10.41	9.50	320	202	1.33	2.13	0.84	1.35	0.332
Flat	.....	.....	.....	.....	303	192	1.26	2.02	0.80	1.28	0.315

See Footnotes on page 8.

Heating · Piping
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The Adaptability of Precooling Coils to Air Washer Systems

By John Everetts, Jr.,* (*MEMBER*), New York, N. Y.

THE use of cooling coils in an air conditioning system has long been recognized as having certain definite advantages over a system employing only an air washer. This is particularly true of comfort conditioning where the exact simultaneous control of temperature and humidity is not as important as it is in an industrial installation.

A system using a saturation type air washer and reheat, however, can be designed to meet any exacting requirements, because the absolute moisture content, which is a function of the dew point, is obtained by saturating the air at a predetermined temperature and the dry-bulb is controlled by reheat. It is the aim of this paper to show the advantage of using both a cooling coil and an air washer in the same system.

The psychrometric characteristics of a vapor-air mixture are such that the moisture load and sensible load must be considered as separate entities in any heat transfer problem where these two factors vary to any degree. In an air washer, the heat transfer reaction necessary to fix the absolute moisture content is to first adiabatically saturate the air by intimate contact between the vapor-air mixture and the atomized spray, and then a sensible heat transfer between the saturated mixture and the spray water. The heat transfer efficiency is a function of (1) the total heat to be removed, (2) the intimacy of contact between the vapor-air mixture and the spray water, (3) the length of time of contact, and (4) the surface area of the spray water to which the vapor-air mixture can dissipate its heat. The total heat to be removed is, of course, a function of the difference between the entering and leaving wet-bulb temperatures. The intimacy of contact is dependent upon the degree of atomization of the spray water, and the length of time of contact is a function of the length of the washer and the air velocity through the washer. The contact surface area is a function of the atomization and quantity of water sprayed.

A good commercial air washer to do the dehumidifying, cooling and saturating in an industrial installation will require approximately 12 to 15 gpm of spray water per 1,000 cfm with a temperature rise in the water of from 5 to 6 F. Spray nozzle pressures of from 18 to 30 lb are necessary to sufficiently atomize the water for this duty. Assuming a saturation efficiency of 90 per cent, the leaving water temperature for 10 F entering wet-bulb depression would be approximately one degree lower than the leaving wet-bulb of the air, and the leaving dry-bulb one degree higher than the leaving wet-bulb. This means the entering water must be 6 to 7 F lower than the required leaving wet-bulb. As the air leaving the washer is within one degree of saturation, the dew point will be within approximately one-half a degree of the leaving water temperature. It must be kept in mind, however, that if the total heat removal is such that a rise in the spray water temperature of more than 6 F is required, then a 2-stage or multi-stage washer is necessary in order to keep the terminal temperatures of air and water within the prescribed limits. As the air velocity, water quantity, outlet water temperature, and pressure on the nozzles are kept constant, keeping the leaving saturation temperature constant for a decreased load will result in a rise in the inlet water temperature to balance this load.

A cooling coil, however, has entirely different characteristics from an air washer. The transfer of heat from the vapor-air mixture to the water is made through an intermediate surface of fixed area. Assuming the air velocity to be constant, the leaving condition of the air will vary with a change in either and both the entering dry-bulb and wet-bulb, change in water velocity, and change in total heat removal which affects the temperature rise of the water in the coil. The heat removed from the air by the water in the coil is total heat, the same as in the case of a washer so long as the entering dew point is above the required leaving dew point, and the coil may be designed to give a saturated leaving air condition under certain entering conditions. However, if the entering wet-bulb is higher than the required leaving wet-bulb, as shown in Fig. 1, thus requiring cooling effect, and the entering dew point is lower than the required leaving dew point, the heat removal is all sensible heat affecting only the dry-bulb temperature and resulting in an indeterminate delivered dew point. However, as the total heat removal is a function of the variables affecting the heat transfer, then a coil may be designed to maintain a constant leaving wet-bulb temperature so long as this temperature is lower than the entering wet-bulb temperature. With a fixed coil surface area, the external variables affecting the heat transfer rate are (1) air velocity, (2) dry-bulb temperatures, and (3) dew point. An increase in air velocity increases the heat transfer because it tends to reduce the film layer on the coil surface thus reducing the film resistance. An increase in dry-bulb temperature increases the heat transfer because of the increased mean effective temperature difference (M. E. D.) between the air on the outside and the water on the inside. An increase in dew point may or may not increase the heat transfer rate.

*Air and Refrigeration Corporation.
Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Swampscott, Mass., June, 1937.

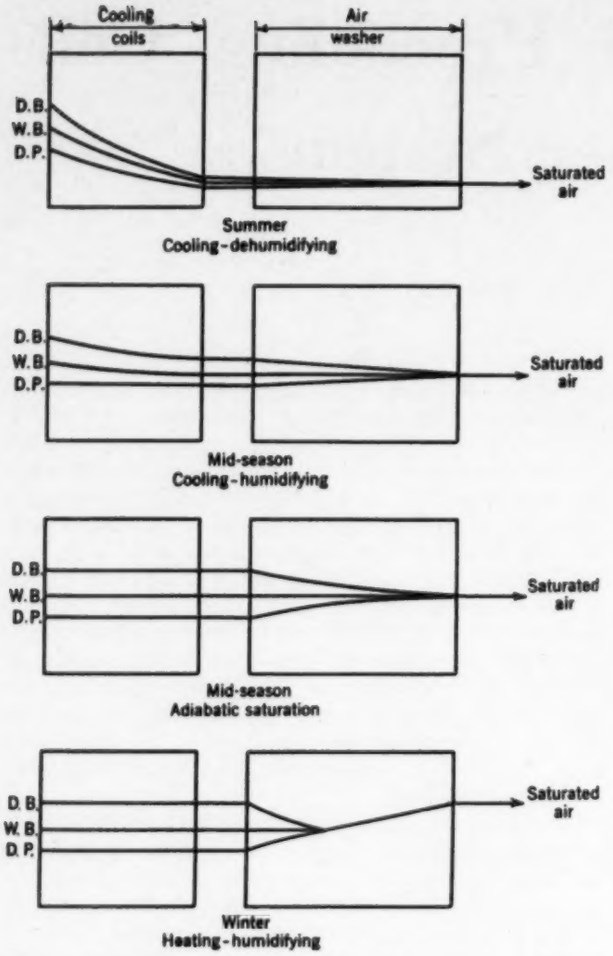

Fig. 1—Air temperature variations through precooling coils and air washers for different seasons

If the dew point is above the coil surface temperature, condensation will take place and wet the surface of coils which would increase the rate of heat transfer; however, if a finned coil is used with the fins so close together that the water builds up between them, the effective surface area of the coil is reduced, thus decreasing the heat transferred.

The internal variables are (1) water velocity which governs the quantity, and (2) water temperature. The water velocity affects the heat transfer by changing the thickness of the film layer on the inside of the tube, and the quantity of water affects the M. E. D. because of the quantity of heat absorbed which governs the temperature rise. The temperature governs not only the M. E. D. but the amount of wetted surface due to condensation for a given dew point of the entering air.

In spite of the many variables encountered in the proper design of a cooling system the coils have many advantages over a spray type dehumidifier. The heat exchange is counter-flow in a cooling coil, whereas in a washer it is cross-flow. That is, the water temperature leaving the cooling coil may be higher than the air temperature leaving the coil as compared to an air washer where the leaving water must be lower than the leaving air. This directly affects the suction pressures of a refrigerating system and also makes it possible to use well water in many cases. The heat transfer characteristics are such that a temperature rise of the chilled water of 10 to 15 F may be obtained in a cooling coil, whereas in a washer a rise of only 5 to 6 F may be obtained resulting in a circulated water quantity of from ½ to ⅓ of that required in a washer. The water friction through the coils is considerably less than the pressure required on air washer nozzles, thus resulting in additional pump power saving. One of the most important characteristics, however, is the fact that the air does not come in direct contact with the chilled water.

In certain industrial plants where the water is cooled in a central refrigerating system and distributed to local conditioning units, it might be disastrous if the odors or flavors picked up by the air washer water in one department were allowed to circulate in an air washer in an entirely different department. The coils or closed systems are the only alternative to this frequently disturbing problem.

In the design of an air washer system with precooling coils, it is usually preferable to design the coils to carry the full cooling load. As the cooling coil surface varies with the M. E. D., and the water quantity varies with the total heat, the coil should be designed with the lowest dry-bulb temperature which may frequently occur coincident with the design wet-bulb. That is, if the general design conditions for air conditioning are 90 F dry-bulb and 75 F wet-bulb, then the coil should be designed for a condition of 75 F saturated air, which occurs almost as frequently as the 90-75 condition. The 15 F difference in the outside temperature may not necessarily reduce the total load in the conditioned spaces by more than a few per cent, because in industrial air conditioning, the product load, people and motors are so great a proportion of the total load that the transmission load is not the predominant factor. This is not always the case, however, and it is, therefore, good practice to check these values before considering the coil design conditions.

The following design conditions of a system have been selected to illustrate some of the pertinent points which must be considered in designing a combination coil and washer system.

Outside Air —90 F Dry-Bulb—75 F Wet-Bulb
Return Air —70 F Dry-Bulb—50 per cent Relative Humidity
Delivered Air—46 F Saturated

Case I — 15 per cent Outside Air—85 per cent Return Air
Case II — 50 per cent Outside Air—50 per cent Return Air
Case III—100 per cent Outside Air— 0 per cent Return Air
Case IV—100 per cent Outside Air— 0 per cent Return Air
—Outside Wet-Bulb—46 F

In Case I where only 15 per cent outside air is used, there is no increase in coil surface with lowering of the outside dry-bulb temperature and with fixed design wet-bulb. The reason for this is that the net change of dry-bulb of the entering mixture is very small, although it is sufficient to reduce the sensible heat load to compensate for the lower K factor, thus giving approximately the same surface area.

In Case II the drop in outside dry-bulb temperature is more apparent in the mixture and requires approximately 3 per cent more surface at the 75 F saturated condition of outside air than at the condition of 90 F dry- and 70 F wet-bulb.

In Case III where all outside air is used, the increase in surface caused by the decrease in dry-bulb temperature is approximately 12 per cent or enough to seriously

affect the proper operation of a system when a 75 F saturated condition occurs.

Case IV illustrates the point previously referred to in the paper that if the wet-bulb entering the coil is at or below the required delivered dew point and the entering dry-bulb is above this point, there can be no control of the delivered dew point. As it is necessary to reduce the entering dry-bulb, it is necessary to use refrigeration effect as indicated. If an air washer is used in conjunction with the coils, the air at conditions shown in Case IV could be adiabatically saturated at the entering wet-bulb, thus eliminating the necessity of refrigerating effect and definitely controlling the delivered dew point at the same time. The annual saving in operating costs of the refrigerating equipment is usually greater than the added cost of a saturation type washer.

The power required to operate the saturation type washer in conjunction with the coils is only 2 to 5 per cent greater than the total power requirements of the normal system taking into consideration the saving in power of the smaller chilled water pump due to the smaller water quantity and smaller total head. The fan power is increased by the resistance of coils on the washer, and may or may not make a considerable difference in the total power, depending upon the type and design of the air handling system.

Table 1—Design Conditions for Combination Coil and Washer System

Outside Air Temperature in Deg F	Air Temperature Entering Coil in Deg F			Air Temperature Leaving Coil in Deg F			Total Heat Removed Btu/Hour	K Factor Btu/Hour/Sq Ft/Deg F	Surface Sq Ft
	D.B.	W.B.	D.P.	D.B.	W.B.	D.P.			
Case I—15 Per Cent Outside Air									
90—75	72.5	61.3	54.2	47.0	46.0	45.0	3060	153	970
75 Sat.	70.8	61.3	55.5	47.0	46.0	45.0	3060	149	968
70 Sat.	70.0	60.5	54.7	47.0	46.0	45.0	2870	152	962
60 Sat.	68.0	58.7	52.3	47.0	46.0	45.0	2460	153	825
Case II—50 Per Cent Outside Air									
90—75	80.0	67.5	61.3	47.0	46.0	45.0	4570	146	1190
75 Sat.	72.5	67.5	65.1	47.0	46.0	45.0	4570	132	1225
70 Sat.	70.0	64.7	61.1	47.0	46.0	45.0	3840	135	1080
60 Sat.	65.0	59.0	55.0	47.0	46.0	45.0	2580	142	930
Case III—100 Per Cent Outside Air									
90—75	90.0	75.0	69.0	47.0	46.0	45.0	6700	139	1465
75 Sat.	75 Sat.			47.0	46.0	45.0	6700	115	1640
70 Sat.	70 Sat.			47.0	46.0	45.0	5400	117	1390
60 Sat.	60 Sat.			47.0	46.0	45.0	2740	123	980
50 Sat.	50 Sat.			47.0	46.0	45.0	714	133	378
Case IV—100 Per Cent Outside Air									
60—46	60.0	46.0	30.0	47.0	40.0	30.0	1065	170	615
55—46	55.0	46.0	32.0	47.0	42.0	37.0	658	170	450
50—46	50.0	46.0	42.5	47.0	44.5	42.5	246	170	212
46 Sat.	46 Sat.			46.0	46.0	46.0	.....	.....	.....

In many industrial problems, it is advantageous to remove from the air the soluble gases, and other impurities which filters and cooling coils cannot take out, but which can be removed by an air washer.

The automatic controls necessary for the proper summer and winter operation of a combination of precooling coils and air washer are greatly simplified, as indicated in Fig. 2, over the conventional system of controls required for this duty. The thermostat, located either in the washer tank, washer outlet, or pump suction, controls the quantity of chilled water to the cooling coils through the throttling valve, or the quantity of steam to either the water heater or an air pre-heater to control the wet-bulb of the air entering the washer. It must be kept in mind, however, that the washer must be of the saturation type in order that this control may adequately fix the dew point of the air leaving the washer.

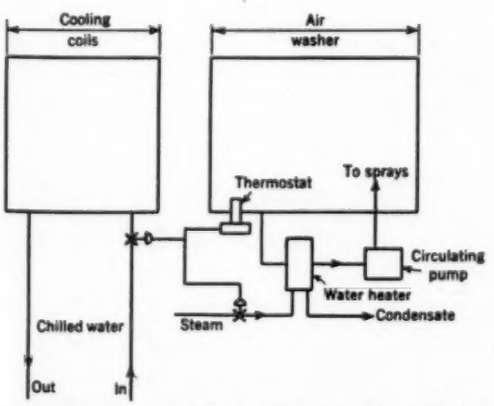

Fig. 2—Automatic control of precooling coils and air washer

It is much simpler in this type of system to drain the washer, hose it down with fresh water and refill it, than it is to completely change the water in the chilled water circuit as would be necessary if the chilled water was not in a closed system.

The winter operation of such a system is the same as a conventional air washer system.

The reheat requirements in the summer are also the same as in a conventional air washer system in which either low pressure steam or a by-pass may be used. If a by-pass is used, it is preferable to use a washer of full fan capacity to take advantage of evaporative cooling and saving in refrigerating operating costs when the outside wet-bulb is suitable.

With the refined development of cooling coils and the established dependability of the air washer, the combination of the two properly designed brings the problem of industrial air conditioning and comfort cooling nearer to the criterion of perfection.

Summary

1. The combination of precooling coils and an air washer gives the accumulated advantages of each and none of the disadvantages to a system where exact year-'round control is required.
2. The use of coils alone will not give a control of the delivered dew point unless the entering dew point is higher.
3. The use of an air washer alone is limited in cooling capacity and under certain conditions cannot carry the load unless multi-staging is used.
4. The combination of cooling coils and air washer eliminates these two major objections, and gives positive year-'round control of air conditions.

Calculated Over-all Coefficients for Walls with Air Space Insulation

By F. B. Rowley* (*MEMBER*), Minneapolis, Minn.

THE over-all coefficient of heat conductivity U for a wall can be readily calculated if the thermal properties for the materials from which the wall is built are known, and if these materials are all placed uniformly over the full area of the wall in such manner that all of the heat must pass through all of the uniform layers of material in series. In this case the over-all heat resistance of the wall is equal to the sum of the heat resistances of the various materials and is uniform for all areas of the wall.

If the materials are not of uniform thickness over the full area of the wall as is the case when insulating materials are placed between the studs of a frame wall or in the cores of hollow concrete block or tile walls, then all of the heat passing through the wall does not pass through equal thickness of all materials and the heat resistance is not the same for all areas of the wall. In these cases there are parallel paths of heat flow and the heat resistance may be entirely different for the various paths. In some instances the heat resistance for the parallel paths are so nearly equal, or other conditions in the wall are such, that all sections of it may be considered as having uniform heat resistance and the simple method of adding heat resistances to determine the over-all coefficients may be followed. There are, however, many combinations of materials which should be used with caution when an insulated wall is required, and in some instances present practice should be somewhat modified in order to get a true picture of the insulating value of material as applied. To illustrate these principles a few examples will be discussed, and in discussing them the standard coefficient of conductivity and conductance for various sections of the wall will be used as given in THE A.S.H.V.E. GUIDE. Briefly it should be remembered that the reciprocal of any conductivity or conductance coefficient for a specific part of the wall represents the heat resistance of that particular part of the wall, and that if the materials are placed in uniform layers so that all of the heat must pass through them in series, the summation of all resistances represents the over-all resistance of the complete wall section. Thus the resistance of individual parts of the wall through which the heat flows in series may be added and the reciprocal of this summation will be equal to the over-all coefficient of conductivity for the complete wall. A more complete discussion of the problem may be found in THE GUIDE.

To illustrate the principle involved consider the four walls, Nos. 1, 2, 3 and 4 of Fig. 1, each made of $\frac{1}{16}$-in. thick steel plates spaced $3\frac{5}{8}$ in. apart and no additional surface finishes. In Wall No. 1 there are no supports between the surfaces which would form a path for heat flow. Wall No. 2 is the same as Wall No. 1 with the exception that the air space between the plates is filled with a homogeneous insulating material. In Wall No. 3 there are $\frac{1}{8}$ in. thick steel studs spaced 16 in. on center and securely bonded by a weld to each of the steel surfaces. Wall No. 4 is the same as No. 3 with the exception that insulating material has been added between the studs. For the purpose of calculating the over-all coefficients of conductivity U for the various walls consider the coefficients of the different materials as follows:

Surface conductance, f_i and f_o = 1.65
Thermal conductivity k for steel = 420
Air space conductance, 1 in. or more in thickness = 1.1
Thermal conductivity k of insulating material = 0.27
Thermal conductivity k of wood (to be used in Walls Nos. 5 and 6) = 0.8.

In the four walls under consideration the heat resistance is the same for the exterior and interior surfaces and

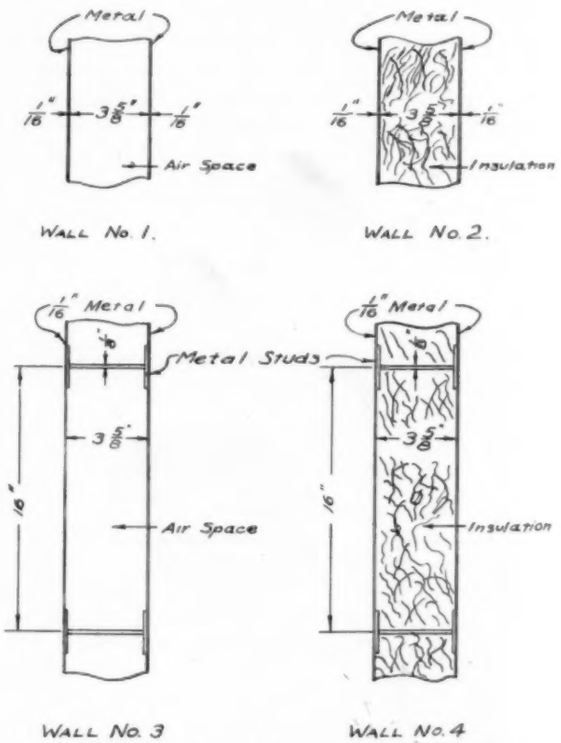

Fig. 1—Typical metal frame wall construction

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also for the steel plates forming two sides of the wall. The resistance of the steel plate is, however, so small in comparison with other parts of the wall that it may be neglected in making calculations. In Walls Nos. 1 and 2 all of the heat flowing through the central section of the wall passes through paths of equal resistance. For Walls Nos. 3 and 4 the heat flows in parallel paths of very different heat resistances and the calculations for these walls must be made on an entirely different basis.

Metal Frame Wall Construction

In calculating the over-all coefficient for the four walls the resistance for the surfaces and everything excepting the central section may be taken as equal for all walls, and since the material itself has such a low resistance the total resistance for this part of all walls will be equal to that of two surface coefficients, or $2/1.65 = 1.21$. The

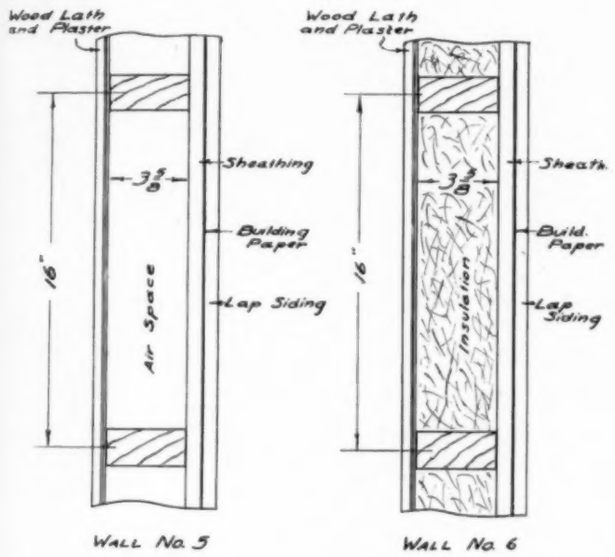

Fig. 2—Typical wood frame wall construction

total heat resistance for Wall No. 1 becomes $1.21 + 1/1.1 = 2.12$, and $U = 1/2.12 = 0.472$. For Wall No. 2 the resistance becomes $1.21 + \frac{3.625}{0.27} = 14.61$ and $U = \frac{1}{14.61} = 0.069$. In this application the insulating material has covered the full area of the wall and the full heat resistance of the material is introduced into all paths for heat flow through the wall, and the resistances of all materials may be properly added to obtain the over-all heat resistance of the wall.

For Walls Nos. 3 and 4 the conditions are entirely different; there are parallel paths of different thermal conductivities through which the heat may flow. Since the steel surfaces of the walls are themselves good conductors, the heat will be free to flow laterally through these surfaces and feed any paths of heat flow through the wall to its full conducting capacity, and there will be substantially parallel flow at different rates through the various sections.

If parallel flow of heat is accepted for walls of this type, the average conductivity for the central section may be calculated and the reciprocal of this taken as the average resistance of that part of the wall. The calculations are as follows:

Table 1—Calculated Coefficients for Walls Nos. 1, 2, 3 and 4

Wall No.	1	2	3	4
Over-all conductance.....	0.47	0.069	0.59	0.45

For Wall No. 3:

$$\text{Average conductance} = \frac{\left(\frac{420}{3.625} \times 0.125\right) + \left(1.1 \times 15.875\right)}{16} = 2.00$$

and R for the complete wall $= 1.21 + \frac{1}{2.00} = 1.70$;

$$U = \frac{1}{1.70} = 0.59$$

For Wall No. 4:

$$\text{Average conductance} = \frac{\left(\frac{420}{3.625} \times 0.125\right) + \left(\frac{0.27}{3.625} \times 15.875\right)}{16} = 0.98$$

and R for the complete wall $= 1.21 + \frac{1}{0.98} = 2.23$;

$$U = \frac{1}{2.23} = 0.45.$$

Table 1 shows the calculated over-all coefficients for the walls with and without insulation applied, and, while it may not be strictly correct to assume parallel heat flow through the materials making up the central sections of Walls Nos. 3 and 4, this is substantially the condition which would exist when there are high conductivity materials forming the two surfaces of the walls, and shows a condition often overlooked in the application of insulating materials. If the surface materials were of low conductivity there would still be a high rate of heat conductance through the steel studs but the problem would be more complicated to calculate and any insulating material between the studs would be more effective. There would, however, be cold spots or lines on the inside surface of the wall over the studs in cold weather. The necessity of spreading insulating material over the full area of the wall and eliminating any path of high conductivity through insulated sections of a wall was discussed in a previous paper.[1] The ultimate effect of any paths of high conductivity will depend upon their area in comparison to the total area of the wall and upon the ease with which heat may be fed to and taken away from these paths. For instance, if the materials making up the inner and outer surface finishes of the wall are of high conductivity, then any path through the wall of high conductivity will do much more damage than if the surfaces are made up of some material which has a high heat resistance and will not conduct the heat laterally to channels where it may easily pass through the wall.

Wood Frame Wall Construction

A condition met extensively in practice is shown by Walls Nos. 5 and 6 in Fig. 2. These may be considered as typical frame construction using 2x4 in. studs spaced 16 in. on center with an inside surface finish composed

[1] Thermal Properties of Concrete Construction, by F. B. Rowley, A. B. Algren and Clifford Carlson, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, January, 1936.

of wood lath and plaster, and an outside surface finish of fir sheathing, building paper and lap siding. Wall No. 6 is insulated with a fill material having an assumed conductivity coefficient k of 0.27 per inch of thickness. The surfaces of these walls are not of high conductivity material, yet the plaster on the inside surface does have a rather high conductivity when compared with the other materials in the wall. It has become common practice with walls of this type to add insulating materials between the studs of the wall and to credit the insulating value of this material to the entire surface of the wall. Since the wood studs are in themselves fairly good insulators this method of calculation does not lead to the same error that it would for a steel wall with steel studs, but nevertheless it does lead to an error and repeated tests on frame walls insulated in this manner have shown that the over-all coefficients as determined by tests are higher than those calculated for the wall when assuming that the insulating material covers the full area of the wall. If, however, the calculations for the central section of the wall are made on the basis of parallel flow through the insulating material and the studs, the calculated results check very closely with test results.

On the basis of parallel flow the average conductance coefficient for the central section of Wall No. 5 when calculated is,

$$\frac{\left(\frac{0.8}{3.625} \times 1.75\right) + \left(1.1 \times 14.25\right)}{16} = 1.003.$$

Many tests have shown that the conductances of the central section of walls of this type where the air space is over 1 in. in thickness is substantially the same whether the studs are present or not. This is probably due to the fact that there is a transfer of heat between the surfaces of the studs bounding the air space and the air in the space and 1.1 may be considered as a fair value to assign to this space for a wall constructed as No. 5.

Fill Insulation

For Wall No. 6 the conductance coefficient for the central section is,

$$\frac{\left(\frac{0.8}{3.625} \times 1.75\right) + \left(\frac{0.27}{3.625} \times 14.25\right)}{16} = 0.0905.$$

The total heat resistance which should be credited to material added between the studs is the difference in heat resistance over the central section of the wall between the insulated and non-insulated walls. In terms of heat resistance, this becomes

$$\frac{1}{0.0905} - \frac{1}{1.003} = 10.05$$

as the actual heat resistance added to the wall, whereas by the method which has been in common use, of crediting the insulation with the full area of the wall, the added resistance would have been

$$\frac{3.625}{0.27} - \frac{1}{1.1} = 12.52,$$

a difference of $12.52 - 10.05 = 2.47$.

This difference becomes an appreciable factor when considering walls with heavy insulation between the studs. In the particular example quoted, Wall No. 5 without insulation and with a 15 mph wind velocity over the outside surface has a commonly accepted over-all coefficient $U = 0.25$. If in the addition of insulation between the studs having a coefficient of 0.27, calculations are made in the commonly accepted manner giving the insulation credit for the full area of the wall and deducting the value of an average air space, the final heat resistance will be,

$$R = \frac{1}{0.25} - \frac{1}{1.1} + \frac{3.625}{0.27} = 16.52 \text{ and } U = \frac{1}{16.52} = 0.061.$$

If the calculations for the insulated wall are made on the basis of parallel flow and insulation is credited for only that part of the wall actually covered by the insulation, the total heat resistance of the wall becomes,

$$R = \frac{1}{0.25} + 10.05 = 14.05, \text{ and } U = \frac{1}{14.05} = 0.072.$$

Conductivity tests by the hot box method for frame walls insulated as in Wall No. 6 show a conductivity coefficient somewhat higher than that calculated by the method of parallel heat flow, indicating that the studs are effective in carrying a somewhat higher proportion of the heat than is credited to them by this method of calculation. The difference, however, is not great and probably 0.075 would be an average over-all test coefficient for such a wall.

Reflective Insulation

A similar practice has been followed in making calculations for reflective insulation placed between the studs of frame walls. The insulation has been credited with covering the full area and not confined to that part between the studs. The same condition exists for this type of insulation as for the fill insulation, and the same precautions must be taken in making calculations. As in the case of fill insulation the errors may be very great for walls built of high conductivity material.

Summary

A brief analysis of the revised over-all coefficients of heat conductivity values given in Chapter 5 of THE GUIDE 1937 shows that the figures are more precise where insulation covers only a portion of the frame wall construction. Wall No. 41-I in THE GUIDE 1936 insulated with rockwool fill between the studs had an over-all coefficient of 0.061, while the coefficient for the corresponding wall, No. 65-I in the 1937 edition is 0.072. Similar revisions are found in the coefficients for walls with reflective types of insulation used between studs. For example, Wall No. 41-H in THE GUIDE 1936 with bright aluminum foil as a lining for one side of the air space between the studs had a coefficient of 0.19 and the corresponding wall No. 65-H in THE GUIDE 1937 has a coefficient of 0.20.

In most cases the new coefficients in THE GUIDE show relatively small changes, although in comparing the coefficients on a percentage basis they become more important.

Ventilation Requirements

(Part 2)

By C. P. Yaglou* (*MEMBER*) and W. N. Witheridge** (*NON-MEMBER*)

Boston, Mass.

This is the second progress report of research sponsored by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS *in co-operation with the School of Public Health, Harvard University*

IN a previous paper[1] it was found that the number of persons occupying a room, or the air space per occupant, is a very important factor affecting the per capita outdoor air supply for the control of body odors. In a room with a net air space of 1,410 cu ft, an outdoor air supply of 7 cfm per capita was found to be required when the room was occupied by three adult persons of average socio-economic status; 16 cfm per capita when occupied by seven persons; and 25 cfm each with fourteen persons in the room.

Additional work presented in the present paper reveals two important factors responsible for this variation: (a) spontaneous disappearance of body odors with time; and (b) changes in efficiency of ventilation and odor removal with changes in the amount of air supplied. A third factor suspected at first, namely, adsorption of odors on room surfaces, was found to be of little or no significance.

Spontaneous Disappearance of Odors in an Unventilated Room

Disappearance of Body Odor

Heretofore body odor in the air of occupied rooms was regarded as a more or less stable entity, and the problem of odor control was thought to be mainly one of plain dilution with clean outside air. Evidence obtained during the past two years does not support this view, but indicates that body odors are very unstable, tending to disappear rapidly with time, much faster than most odors with which the ventilating engineer is confronted in public buildings.

All observations of body-odor disappearance rate were carried out in two adjoining rooms, which were separately conditioned,[2] by shutting off all ventilation in the experimental room immediately after the subjects were dismissed, and smelling the strength of body odor at intervals by comparing it with the smell of air kept at threshold-odor intensity in the control room, as in the previous work.[3] The only significant leakage in the closed room was that occasioned in passing back and forth from the control room for determining the odor intensity. By carefully opening and shutting the small door connecting the two rooms, this leakage was kept at a minimum.

In the control room the ventilation rate was maintained at 50 cfm per person throughout, as in the previous work, with not more than two persons in the room at a time. These were the judges who compared odor intensity. All experiments on body-odor disappearance rate were started about 12:30 p. m., after the subjects had been in the room for 3½ hours, from 9:00 a. m. to 12:30 p. m. Observations were continued to 6:00 p. m. or later. At night, the experimental room was closed tight and observations were resumed the following morning, with the normal rate of ventilation in the control room (50 cfm per occupant).

In the lower part of Fig. 1 are shown the results of four experiments carried out under representative conditions in winter and summer with respect to temperature, humidity, clothing, and other factors. It can be seen that in all four instances the strength of body odor fell abruptly from an initial value between 3.5 and 4.0 to the allowable intensity of 2 in less than 4 min after the subjects left the room. Twenty minutes later the odor index was about 1. From then on, the rate of disappearance became very slow, and finally equilibrium was reached at an intensity between 0.5 and 1.0. By this time the odor lost much of its characteristic *human smell* and after 48 hours it was difficult to identify it as such in the presence of other weak odors coming from other sources in the room. A certain minimum amount of ventilation was always necessary to clear out this residual odor, which persisted indefinitely with the room kept tightly closed.

The explanation for the abrupt disappearance rate of body odor is not quite clear. Oxidation would seem to be a most plausible cause. It is possible that some constituents of the body-odor complex are extremely unstable, leaving behind other less odorous but relatively stable constituents which can be smelled for days. The loss of moisture from the organic material to the atmosphere may also have something to do with the loss of odor. Schroeder[4] recently presented some evidence of his own and others, indicating a chemical change in organic matter of expired air after washing with sulphuric acid. The alteration was attributed to dehydration, as the sulphuric acid did not remove an appreciable quantity of organic material. On the other hand, liquid condensed in the present experiments by cooling odorous air

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**Instructor of Industrial Hygiene, Harvard School of Public Health.
[1]Ventilation Requirements, by C. P. Yaglou, E. C. Riley and D. I. Coggins, A. S. H. V. E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, 8, 66, Jan. 1936.
[2]Loc. Cit. See Note 1.
[3]Loc. Cit. See Note 1.
Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Swampscott, Mass., June, 1937.

[4]Elimination of Organic Products in Air Conditioning, by W. K. Schroeder, *Refrigerating Engineering*, 29, 394, Dec. 1935.

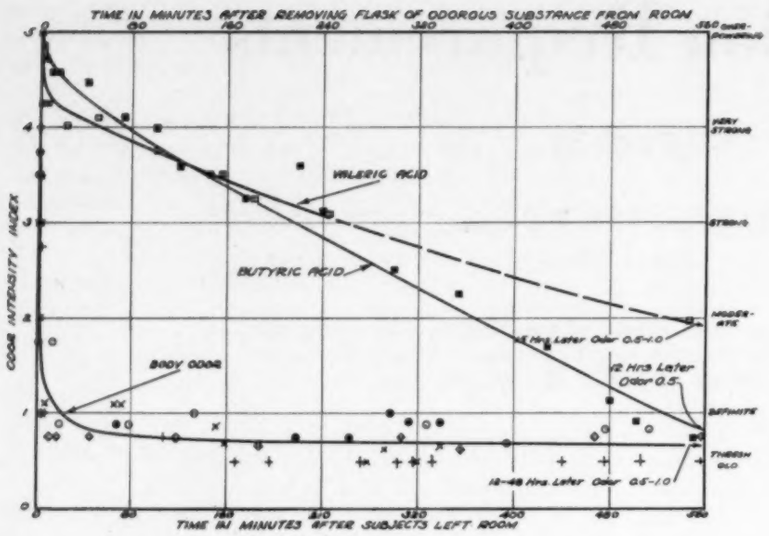
TIME IN MINUTES AFTER REMOVING FLASK OF ODOROUS SUBSTANCE FROM ROOM
ODOR INTENSITY INDEX
VALERIC ACID
BUTYRIC ACID
BODY ODOR
12 Hrs Later Odor 0.5
18-48 Hrs Later Odor 0.5-1.0
TIME IN MINUTES AFTER SUBJECTS LEFT ROOM

Fig. 1 — Disappearance of body odor, valeric and butyric acid, in a closed room

to about 35 F was odorless, clear and neutral in reaction. This is not necessarily contradictory with the work of Gant and Shaw,[5] who froze out odors from the air with dry ice and presumably succeeded in determining their relative strength several days later by the use of an osmoscope. The odors Gant and Shaw worked with were mainly those from tobacco smoke, foods and various kinds of liquors, whereas those in the experiments described in this paper were body odors alone.

The influence of per capita air space on ventilation requirements from the standpoint of body odor would, therefore, seem to be explainable, almost entirely, by the rapid disappearance of odor. The time element is so small that it is difficult to draw a satisfactory odor balance from the odor intensity in the room, number of occupants, air supply, and room dimensions. Even an error of half a minute or more in estimating the time taken by the ventilating current to pass over the occupied zone might make a great difference in the loss of odor and odor balance.

Disappearance of Other Odors

That the rapid loss of odor is due to a characteristic of body odor itself rather than to diffusion by leakage was ascertained by studying the disappearance rate of other stronger odors, such as valeric and butyric acid, tobacco smoke, and ozone, all capable of completely masking body odor. In the upper half of Fig. 1 are shown results with valeric and butyric acid, obtained by exposing in the center of the experimental room a small flask of the odorous substance, with the stopper removed, until the odor intensity rose to 5. With valeric acid it took 25 min, and with butyric acid 30 min to raise the odor strength from 0 to 5. The flask was then removed and observations of odor intensity made at intervals, as in the case of body odors. By comparison with the body-odor curve in the lower half of Fig. 1, the rates of disappearance of valeric and butyric acid are much too slow, lending little support to the assumption often made that body odors are mainly composed of these two substances.

The disappearance characteristics of tobacco smoke are shown in Fig. 2. Curves *A* and *B* were obtained by having subjects smoke one or two cigarettes each inside the experimental room, with no ventilation at all. At the end of the smoking period, after the smokers left and ash trays were removed, the odor intensity was determined at intervals as in previous tests.

Plot *C* (Fig. 2) was obtained with tobacco smoke from two cigarettes produced by fan suction, in order to check the characteristics of the other two curves. After the smoking period the fan and cigarette butts were removed from the room. In all three instances there was a bluish haze at first, particularly when smoke was produced by fan suction, gradually thinning out and changing to whitish color. This suggests flocculation to larger and larger particles, and eventual settling out of the particles.

Unlike body odor, the odor of tobacco smoke (Fig. 2) not only remained longer in the room, but its intensity increased in a peculiar manner during the first three hours following the smoking period. From then on, the intensity began to decrease gradually, finally reaching a stable level of 0.5 after 17 to 48 hours, according to the number of cigarettes smoked.

The rise in odor intensity after smoking seems to

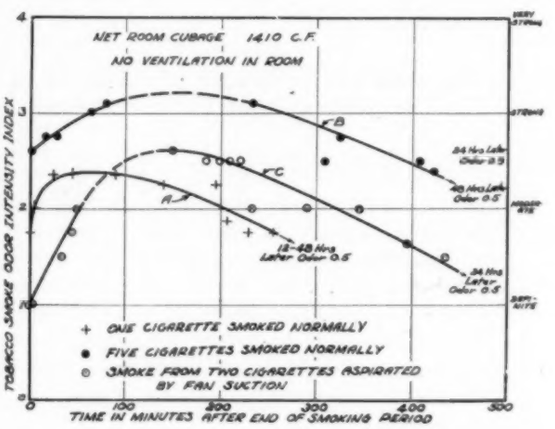
NET ROOM CUBAGE 1410 C.F.
NO VENTILATION IN ROOM
TOBACCO SMOKE ODOR INTENSITY INDEX
A
B
C
12-48 Hrs Later Odor 0.5
+ ONE CIGARETTE SMOKED NORMALLY
● FIVE CIGARETTES SMOKED NORMALLY
○ SMOKE FROM TWO CIGARETTES ASPIRATED BY FAN SUCTION
TIME IN MINUTES AFTER END OF SMOKING PERIOD

Fig. 2—Disappearance of tobacco smoke in a closed room

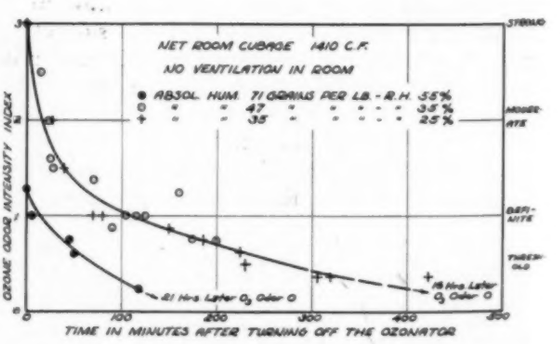
NET ROOM CUBAGE 1410 C.F.
NO VENTILATION IN ROOM
● ABSOL. HUM. 71 GRAINS PER LB. - R.H. 55%
OZONE ODOR INTENSITY INDEX
TIME IN MINUTES AFTER TURNING OFF THE OZONATOR

Fig. 3—Disappearance of ozone in a closed room

[5]Odor Concentration in Air-Conditioned Structures, by V. A. Gant and H. D. Shaw, *Industrial and Engineering Chemistry*, 9, 16, Jan. 15, 1937.

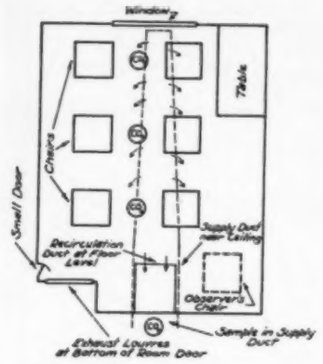

Fig. 4—Plan of experimental room showing location of subjects and sampling stations

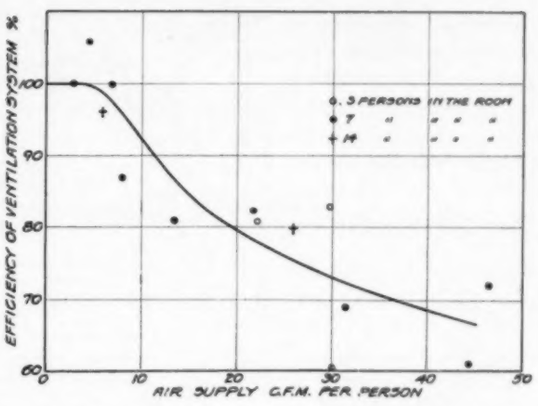

Fig. 5—Efficiency of ventilation system of experimental room at various airflows

agree with common observation that the odor of stale tobacco smoke is more offensive than the odor of fresh smoke. Alterations in physical characteristics of the smoke in passing through the respiratory tract are probably not responsible for this, as shown by curve *C*. Presumably, it would be advantageous to make smoking rooms as small as is practicable and ventilate them fast. The chemical and physical properties of cigarette smoke were recently reviewed by Bradford et al.[6]

Even ozone, which readily decomposes to O_2 and O, appears to be relatively more stable than body odor, as shown in Fig. 3. It is, however, the only one of the odoriferous substances studied by us that eventually disappeared completely without leaving a trace of residual odor of its own. Ozone for the tests was produced by corona discharge between concentric cylindrical electrodes, ⅝ in. apart, kept at a potential difference of 15,000 volts, a-c, 60 cycles. The outer cylinder was glass, lined with metallic foil on the outside. The apparatus was essentially a Cottrell precipitator as modified by Drinker,[7] for small-scale quantitative determination of dusts in air.

The decomposition rate of ozone on a volumetric basis was studied by Ewell[8,9] in a large closed box and in cold-storage rooms. The general characteristics of Ewell's curves are quite similar to those obtained in the tests described in this paper.

Changes in Ventilation Efficiency

Aside from body-odor disappearance rate, the amount of air supply and the number and arrangement of occupants in a room with reference to the location of supply and exhaust openings affect also the efficiency of odor removal. With supply openings near the ceiling located centrally over the occupied zone, as in this system, and a constant air supply per person, an increase in the number of occupants would have two opposing effects on ventilation efficiency. On one hand, it would tend to increase efficiency by spreading out the occupied zone; on the other hand, the greater volume of air needed would allow less time for diffusion over the occupied area, the air passing quickly to the exhaust without removing a full share of odor, CO_2, and moisture.

The problem was studied by determining the relative efficiency of the ventilation system at various rates of air supply and with 3, 7, and 14 persons in the room.

Efficiency of ventilation for the purpose of this study was taken as the ratio of *effective* air supply to the total air supply. *Effective* air supply is that passing over the occupied zone, and capable of removing the products of respiration and transpiration. It was determined from measurements of carbon dioxide in representative areas, in the breathing zone between the seats of occupants. Most of the experiments were carried out with seven adult persons in the room (see Fig. 4), the observer himself serving as subject. All experiments lasted 3½ hours, and the air samples were collected near the end of each test. Carbon dioxide analysis was made by means of a 20 cc modified Haldane apparatus for CO_2 only. The relative ventilation efficiency was computed from the following formula:

$$\text{Ventilation Efficiency} = \frac{0.01}{\dfrac{(CO_2)_r - (CO_2)_s}{\text{Cfm per occupant}}}$$

where

0.01 = cubic feet of CO_2 given off per person per minute.
$(CO_2)_r$ = average CO_2 of air in occupied zone, per cent by volume.
$(CO_2)_s$ = CO_2 in the air supply, per cent by volume.
Cfm per occupant = air supply per occupant in cubic feet per minute measured by means of standardized orifice meters.

It can be seen in Fig. 5 that with airflows under 5 cfm per person, ventilation efficiency was practically 100 per cent, decreasing progressively as the air supply increased. With 30 cfm per person, the efficiency was about 75 per cent. From the standpoint of efficiency, it would seem that rate of air supply is more significant than number of occupants in a room, but the data with three and fourteen persons are too few to draw a conclusion.

The important thing to emphasize is the advantage of large rooms over small ones, as they act like reservoirs, allowing body odor to disappear, with a minimum air supply and maximum ventilation efficiency. Reducing the size of a room entails an increase of ventilation rate and a simultaneous decrease of ventilation efficiency.

Adsorption of Body Odors on Room Surfaces

Adsorption is generally regarded as a physical, rather than a chemical phenomenon consisting in condensation of gas molecules on the surfaces of solid bodies with which they come in contact. The amount of gas adsorbed depends upon its pressure, the chemical natures and potentials of the adsorbents and adsorbate and the physical state of the adsorbing surface. For a great number of systems, adsorption is believed to be complete when the adsorbing surface is completely covered with a uni-

[6] Nature of Cigaret Smoke, by J. A. Bradford, E. S. Harlow, W. R. Harlan and H. R. Hanmer, *Industrial and Engineering Chemistry*, *29*, 45, Jan. 1937.
[7] Alternating Current Precipitator for Sanitary Air Analysis, by Philip Drinker, *Jour. Industrial Hygiene*, *14*, 364, 1932.
[8] The Disappearance of Ozone in Cold-Storage Rooms, by A. W. Ewell, *Refrigerating Engineering*, *26*, Dec. 1930.
[9] The Decomposition of Ozone, by A. W. Ewell, *Ibid*, *29*, Aug. 1933.

molecular layer of the adsorbent.[10] Normally, equilibrium is quickly reached when the rate of evaporation just balances the condensation rate. Exceptions occur when diffusion is slow, or when there is chemical interaction between the adsorbent and adsorbate. The length of time over which the condensed molecules will remain on the surface depends on the strength of the attractive forces between the surface and adsorbed molecules, and the temperature.

Under the conditions of the present experiments, adsorption of body odors on surfaces of walls, ceiling and floor did not seem to be a factor affecting odor intensity and ventilation requirements per occupant, when equilibrium conditions prevailed. This conclusion was arrived at by increasing the amount of adsorbing surface in the room and redetermining the equilibrium time, equilibrium intensity, and rate of disappearance of body odor under the new conditions. All other factors were kept approximately the same in each series of tests.

Plot *A* in Fig. 6 shows the normal variation of odor intensity in a control test with the normal amount of adsorbing surface of walls, ceiling, and floor aggregating 780 sq ft approximately. Odor equilibrium was reached about 50 min after the subjects entered the room, and the equilibrium intensity index averaged nearly 3.5. The disappearance rate in this control test is that already shown in Fig. 1 by similar points.

Plot *B* was obtained under identical initial conditions as plot *A*, except that near the middle of the test the adsorbing surface in the room was increased by 320 sq ft by hanging up sheets of semi-gloss brown wrapping paper vertically over the occupied zone and parallel to the air flow. The lower edges of the sheets hung down to shoulder height of the subjects.

The sudden decrease of odor intensity immediately after hanging up the sheets (Fig. 6) is probably due to a strong static charge acquired by the paper when it was unrolled freshly from a big roll just before hanging it up. The effect was transient, and the odor intensity soon rose to its former level, as can be seen in Fig. 6.

In plot *C* the same paper sheets were hung up in the room 16 hours before the subjects entered, with no apparent effect throughout the test period.

In plot *D* sheets of a spongy cellulose paper used in air filters were employed instead of wrapping paper, with negative results again.

Two experiments with an airflow of 30 cfm per person, instead of 7.5, likewise yielded negative results. The rate

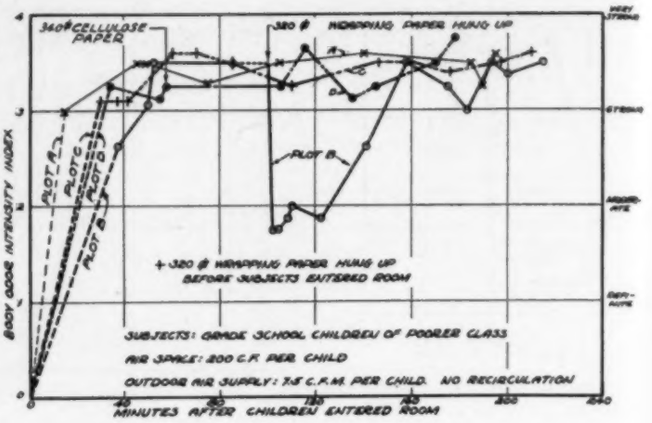
340 ft² CELLULOSE PAPER
320 ft² WRAPPING PAPER HUNG UP
PLOT A
PLOT C
PLOT D
PLOT B
+320 ft² WRAPPING PAPER HUNG UP BEFORE SUBJECTS ENTERED ROOM
SUBJECTS: GRADE SCHOOL CHILDREN OF POORER CLASS
AIR SPACE: 200 C.F. PER CHILD
OUTDOOR AIR SUPPLY: 7.5 C.F.M. PER CHILD. NO RECIRCULATION
BODY ODOR INTENSITY INDEX
MINUTES AFTER CHILDREN ENTERED ROOM

Fig. 6—Equilibrium time and intensity of body odor with and without additional adsorbing surface in the room

of disappearance of body odor at the end of the tests was substantially the same as in Fig. 1.

[10]International Critical Tables, McGraw-Hill Book Company, New York, 3, 250, 1926.

Summary

Body odors are not stable but tend to disappear rapidly in a closed room within a few minutes after the occupants leave. A weak residual odor persists for days unless the room is ventilated.

The unusually rapid disappearance rate is a characteristic of body odor itself, differing greatly from disappearance characteristics of other odors, such as butyric or valeric acid, tobacco smoke, and ozone, all capable of completely masking body odor.

Unlike body odor, the odor of tobacco smoke not only remains longer in the air but its intensity increases during the first three hours following smoking.

Air space per occupant in a room not only affects the disappearance rate of body odors and hence ventilation requirements, but also the efficiency of ventilation systems. Large rooms have an advantage over small ones, as they act like reservoirs, allowing body odors to disappear with a minimum outdoor air supply and maximum ventilation efficiency. A small room would require a greater air supply per occupant for the control of body odor. An increased air supply entails a loss of ventilation efficiency, as the air passes quickly to the exhaust without removing a full share of odors, heat, and moisture.

On the other hand, the problem of tobacco-smoke control would seem to consist in making rooms as small as is practicable and ventilating them fast.

Refrigeration Engineering

In Refrigeration Engineering by H. J. Macintire, a comprehensive treatment of the fundamental theory of thermodynamics and the theoretical cycles of compression machines is given in the first few chapters, which are arranged in this form primarily for senior engineering students studying this subject. Related subjects pertaining to machine design, refrigeration, flow of fluids, heat transfer, evaporation, liquefaction, and absorption are covered in later chapters.

Specific reference is also made to air conditioning and comfort cooling as directly applied to refrigeration and in this connection a few paragraphs are included covering the control of noise transmission through ducts and the sound insulation applicable for machinery mounting. Other subject material covered in this book, which is primarily intended for student instruction, is cold storage, district cooling, ice manufacture, and the use of refrigeration as applied to all phases of transportation.

This book is cloth bound, containing 415 pages, and is available through the publishers John Wiley & Sons, Inc., New York, N. Y., at $4.50 per copy.

Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS is located

Heating Requirements of an Office Building As Influenced by the Stack Effect

By F. C. Houghten* (*MEMBER*), and Carl Gutberlet** (*NON-MEMBER*)
Pittsburgh, Pa.

REVISION of the heat transfer constants, based on laboratory tests at the University of Minnesota, the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and elsewhere, and published in THE A.S.H.V.E. GUIDE 1933, forcibly called to the attention of designing engineers the need for a better understanding of other factors entering into the estimation of heating requirements of buildings. These other factors include the heat capacity of the building, the effect of solar radiation, wind velocity and direction, and the co-incidental effect of low temperature and high wind velocity in effecting a maximum rate of heat loss. The stack effect of tall buildings, together with the probable variation in wind velocity and direction near the base and upper stories of such a building in relation to that reported by the Weather Bureau, are also important factors. Other factors involved include the characteristic operation or usage of the building, the resistance to air circulation through different parts of the building, particularly to air flow upwards from floor to floor in the case of tall buildings, and heat sources within the building itself, such as mechanical equipment, lighting, and the human load.

An intensive study of these factors was initiated with the appointment of a Technical Advisory Committee on Heat Requirements of Buildings in the Fall of 1933 under the Chairmanship of D. S. Boyden. This work has been carried on under the following continuing committee for 1937: O. W. Armspach, *Chairman*, P. D. Close, W. H. Driscoll, H. M. Hart, V. W. Hunter, H. H. Mather, E. C. Rack, F. B. Rowley, R. J. J. Tennant and J. H. Walker.

One important phase in the work of this committee was the collection of a great mass of data during the heating season of 1933-1934, in eight rooms located on three different floors and on three different exposures in the Grant Building in Pittsburgh. Analysis of these data and the publication of the results have been a laborious procedure, requiring a considerable portion of the time of part of the Research Laboratory's staff in succeeding years. In 1934 a report[1] covering the relation between the wind velocity in close proximity to the building to that reported by the Weather Bureau was presented to the Society. In 1936 a more comprehensive report[2] of the relation between the electrical heat input required by

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Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Swampscott, Mass., June, 1937.

[1]Wind Velocities Near a Building and Their Effect on Heat Loss, by F. C. Houghten, J. L. Blackshaw and Carl Gutberlet, A. S. H. V. E. TRANSACTIONS, Vol. 40, 1934, p. 387.
[2]Heating Requirements of an Office Building as Affected by Weather Conditions, by F. C. Houghten and Carl Gutberlet, A. S. H. V. E. TRANSACTIONS, Vol. 42, 1936.

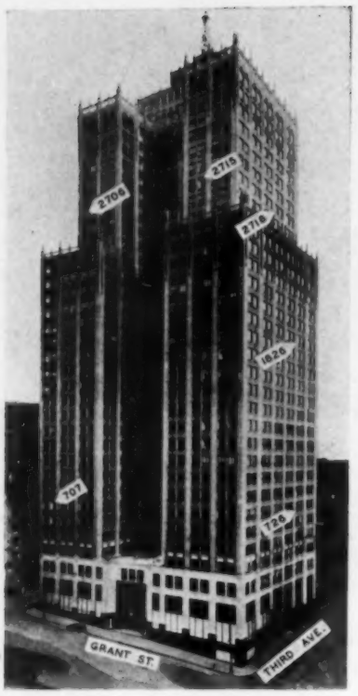


Fig. 1—The Grant Building showing locations of six of the eight rooms used in the study

the different rooms studied to the outside weather conditions and the location of the room in the building was published. In these two reports, the general question of aeration of the building, including infiltration and exfiltration as it is affected by the elevation of rooms within the building, or the stack effect, was given brief consideration. The more complete analysis of the data bearing on these phases of the subjects is included in this report.

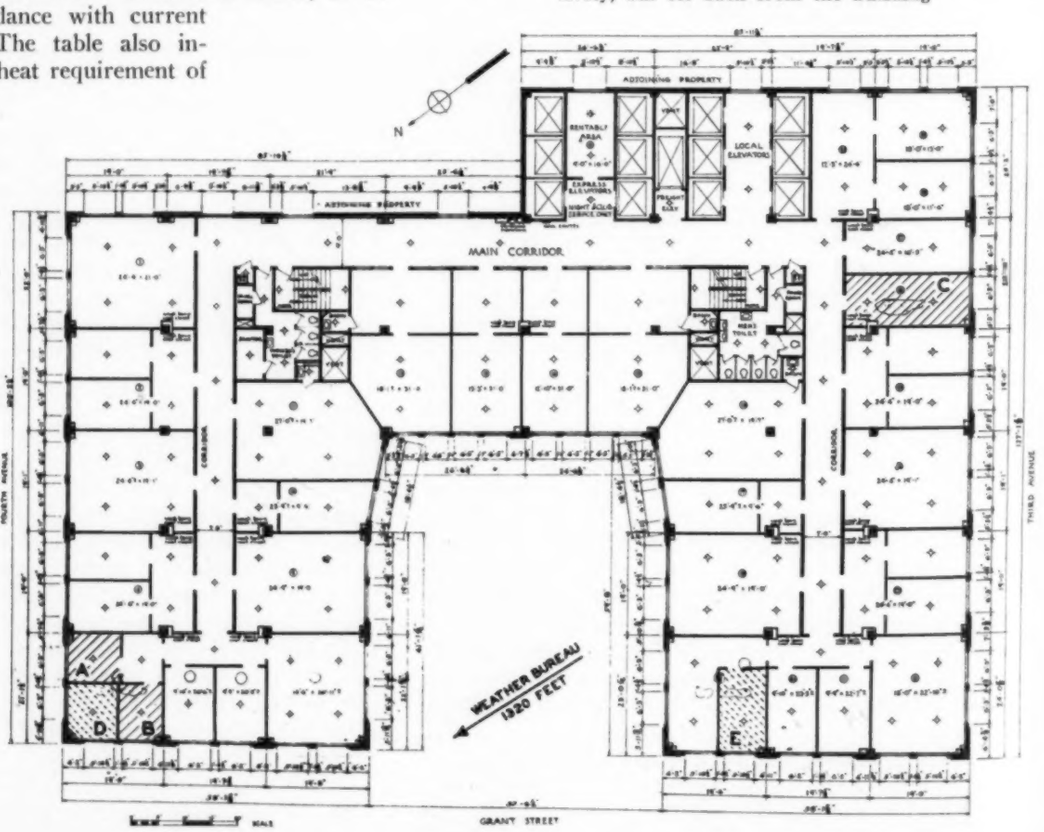
A photograph of the building, showing the location of the several rooms in which the study was made, is presented in Fig. 1. The floor plan, Fig. 2, shows the orientation of the building. Table 1 gives other characteristics concerning the several rooms studied, including the estimated heating requirement based upon transmission and infiltration losses, as determined in accordance with current GUIDE methods. The table also includes the relative heat requirement of the several rooms.

Table 1—Room Characteristics

ROOM NO	EXPOSURE		WALL AREA SQ FT		TRANSMISSION EXPOSED WALL INCLUDING GLASS BTU/HR/SQ F TEMP DIFF	FACTOR TO CORRECT EXPOSURE OF ALL ROOMS TO 1828
	DIRECTION	FACING	MASONRY	WINDOW		
705	N E	4TH AVE	42 62	40.75	84.0	1 04
707	N W	GRANT ST	51.26	38.24	83.6	1 05
726	S W	3RD AVE.	60.21	40.66	89 6	96
1826	S W	3RD AVE	50.59	40 75	86 5	1.00
2703	N E.	4TH AVE	57.87	40.87	89.2	95
2706	N E & N W	4TH AVE GRANT ST	123 14	79.66	139.5	48
2715	N W	GRANT ST	55 09	37 91	84.8	1 03
2718	S W	3RD AVE	61.81	40.62	70.4	95

In order to obtain a better understanding of the infiltration for the different rooms under actual test conditions, a number of tests were made of the rate of infiltration by the carbon dioxide method. The building is equipped with heavy casement rolled section steel sash windows. In the rooms studied the windows were of approximately the same size and tight fitting. Probably for this reason the infiltration observed for the different rooms showed little or no variation when related to the actual pressure drop through the window. Any consistent variation in such leakage for different rooms amounted to no more than the variation indicated by successive tests in the same room. The relation between pressure drop through the windows and the rate of infiltration is given in Fig. 3. All of the rooms studied were of approximately the same size and contained one window, with the exception of room 2706, which was a corner room of approximately the same size but with

Fig. 2—Plan of 4th to 23rd floors of Grant Building, showing rooms A, 705; B, 707; C, 726; and 1826. Rooms 2703, 2706, 2715 and 2718 are similarly situated to A, D, E and C respectively, but set back from the building



double outside wall exposure and containing two windows.

A more comprehensive discussion of the test procedure, method of calculating heat loss by transmission, the electrical heat input, and the heat gain by solar radiation are included in the earlier Laboratory reports[3]. A comparison of calculated, and measured rates of heat loss and heat input, by infiltration, transmission, solar radiation and electrical input are shown in Figs. 4, 5 and 6 for the eight rooms under various outside temperatures.

Values taken from the curves at 50 F temperature difference are given for comparison in Table 2. The calculated infiltration loss based upon THE GUIDE formula

$$M_e = \sqrt{M^2 + 1.75a}$$

where:

M_e = equivalent wind velocity affecting pressure drop through the window.
M = wind velocity upon which infiltration would be determined if temperature difference were neglected, usually 15 mph.
a = distance of windows under consideration from mid-height of building; negative if above, positive if below.

is given by Curve F and Column D for each room.

The heat loss by infiltration based upon the observed pressure drops between the outside and inside is given by Curves G and Column C, when these values are positive. On the 27th floor, the stack effect was sufficient to oppose the effect of wind velocity in almost every observation made, with the result that in the average case a considerable exfiltration or negative infiltration resulted. Since for most considerations exfiltration does not result in negative heat loss or positive heat gain from the building, Curves G are not provided for rooms on the 27th floor, and heat loss values by infiltration are indicated as zero in Column C. The justification for this assumption will be discussed at greater length later in this paper.

[3]Loc. Cit. See Notes 1 and 2.

Table 2—Relation between Heat Supplied to Maintain Temperature and Estimated Heat Losses for the Rooms Studied

A	B	C	D	E	F	G	H	I	J
ROOM NUMBER	CALCULATED TRANSMISSION BTU/HR/°F TEMP. DIFF.	CALCULATED INFILTRATION BASED ON P.D. BTU/HR./°F T.D.	CALCULATED INFILTRATION (GUIDE FORMULA) BTU/HR./°F T.D.	CALCULATED INFILTRATION BASED ON P.D. BTU/HR./°F T.D.	INPUT—ELECTRICAL PLUS 50% SOLAR RAD. BTU/HR./°F T.D.	ELEC. PLUS 50% SOLAR RAD. CAL. TRANS.+INF. COL. $\frac{F}{B+C}$ X 100 %	ELEC. PLUS 50% SOLAR RAD. CAL. TRANS.+INF. COL. $\frac{F}{B+D}$ X 100 %	ELEC. PLUS 50% SOLAR RAD. CAL. TRANS.+INF. COL. $\frac{F}{B+E}$ X 100 %	COL. I CORRECTED FOR ASSUMED EFFECTIVENESS OF SOLAR RADIATION ON GRANT & FOURTH AVES.
705	64.0	32.0	42.0	32.0	88.0	91.7	83.0	91.7	98.7
707	83.8	34.0	42.0	34.0	107.5	110.1	101.8	110.1	107.1
726	89.6	34.2	42.0	34.2	108.5	102.8	95.4	102.8	102.6
1826	86.5	23.2	30.8	23.2	88.7	98.9	91.3	98.9	98.9
2703	89.2	0.0	18.0	-10.6	55.0	79.5	63.1	93.9	98.9
2708	139.5	0.0	36.0	-19.0	126.0	90.3	71.8	105.0	101.4
2715	84.8	0.0	18.0	- 8.8	63.3	97.7	78.4	112.4	104.8
2718	70.4	0.0	18.0	- 8.0	64.5	91.6	73.0	103.4	103.4
3RD AVE. 726 1826 2718						97.7	86.6	101.6	101.6
4TH AVE. 705 2703						85.6	73.0	92.8	97.6
GRANT 707 2715						103.9	89.1	111.2	108.0
7TH FLOOR						101.5	93.4	101.5	102.1
18TH FLOOR						98.9	91.3	98.9	98.9
27TH FLOOR						89.8	71.1	103.7	102.1
ALL						95.3	82.0	102.2	101.7

COL. B BASED ON THE GUIDE HEAT TRANSMISSION COEFFICIENTS AND 50 F TEMPERATURE DIFFERENCE.

COL. C BASED ON THE AVERAGE OBSERVED PRESSURE DIFFERENCE THROUGH THE WINDOW FOR ALL TESTS. THE OBSERVED RELATION BETWEEN THE PRESSURE DIFFERENCE AND AIR FLOW AND A 50 F TEMPERATURE DIFFERENCE FOR 7TH AND 18TH FLOORS AND NO HEAT LOSS BY INFILTRATION FOR THE 27TH FLOOR.

COL. D BASED ON INFILTRATION BY GUIDE FORMULA

COL. E BASED ON THE AVERAGE OBSERVED PRESSURE DIFFERENCE THROUGH THE WINDOW FOR ALL TESTS, THE OBSERVED RELATION BETWEEN THE PRESSURE DIFFERENCE AND AIR FLOW, AND A 50 F TEMPERATURE DIFFERENCE FOR 7TH AND 18TH FLOORS AND NEGATIVE HEAT LOSS FOR 27TH FLOOR BASED ON SAME PRESSURE AND INFILTRATION RELATIONSHIP BUT TEMPERATURE DIFFERENCE TAKEN FROM ROOM AIR TO GLASS.

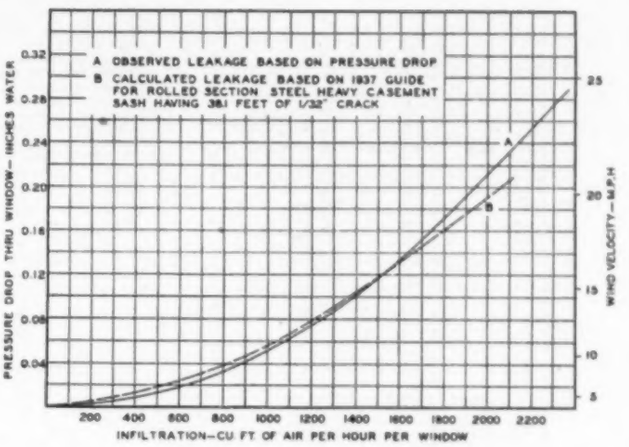


Fig 3—Relation between infiltration through the windows of the Grant Building and pressure drop

The heat input by electric heaters used in maintaining room temperatures is given by Curves D, and the sum of the electrical input and 50 per cent solar radiation is given by Curves C. Since rooms 705 and 2703, facing northeast, received no appreciable solar radiation, Curves C and D are the same. Curves C and Column F represent the measured total heat input required to maintain the room at the predetermined temperature. Curves A and B for each room represent the estimated heat requirement by transmission and infiltration based upon THE GUIDE formula, and by transmission and infiltration calculated from the observed pressure drop, respectively.

The agreement between Curves C and B on the one hand, and between Curve C and Curve A on the other, for each room, indicates the degree of agreement between the actual heat input and the estimated heat requirement based on infiltration calculated by the two methods. These comparisons are given on a percentage basis in Columns G and H. It will be observed that considerably better agreement is had when the infiltration is based upon the observed pressure drop through the window. The average percentages by floors given in Column G show fairly good agreement, or percentages near 100 for the 7th and 18th floors, but poor agreement for the 27th floor. The lower percentage of 89.8 for the 27th floor indicates that even when no heat loss by infiltration is charged to the 27th floor, the calculated heat loss is measurably greater than the heat supplied. This suggests that the assumption that there is no negative heat loss by infiltration on the 27th floor where air is blown out may be in error, or in other words, that there is actual heat gain by exfiltration for these rooms.

Due to the stack effect of the building, cold air flows in through every crack and crevice on the lower floors, passes upward through the building and outward in equal mass through cracks and crevices in the windows and walls of the upper floors. Every pound of outside air at its prevailing temperature entering the lower part

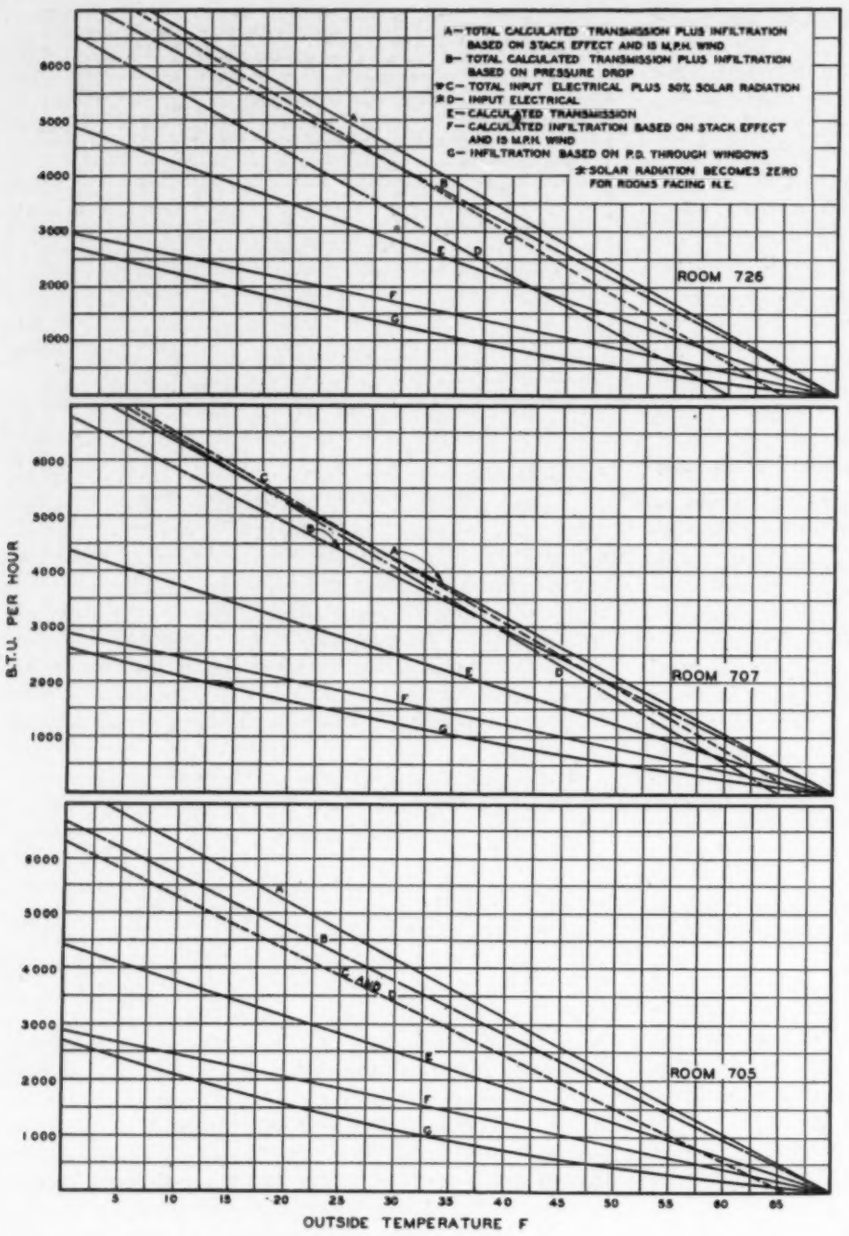

A—TOTAL CALCULATED TRANSMISSION PLUS INFILTRATION BASED ON STACK EFFECT AND 15 M.P.H. WIND
B—TOTAL CALCULATED TRANSMISSION PLUS INFILTRATION BASED ON PRESSURE DROP
*C—TOTAL INPUT ELECTRICAL PLUS 50% SOLAR RADIATION
*D—INPUT ELECTRICAL
E—CALCULATED TRANSMISSION
F—CALCULATED INFILTRATION BASED ON STACK EFFECT AND 15 M.P.H. WIND
G—INFILTRATION BASED ON P.D. THROUGH WINDOWS
*SOLAR RADIATION BECOMES ZERO FOR ROOMS FACING N.E.
ROOM 726
ROOM 707
ROOM 705
B.T.U. PER HOUR
OUTSIDE TEMPERATURE F

Fig. 4—Relation between outside temperature and heat input to and loss from rooms on the 7th floor

of the building must be heated to 70 F, in order to maintain room temperature, and hence, the assumption with regard to this heat requirement cannot be much in error. On the other hand, air leaking into rooms in the upper part of the building from the floors below does not need to be heated up before leaving. It must, however, be cooled down to the prevailing outside temperature somewhere in its passage from the uniformly heated portion of the room to the uniform outside temperature some distance from the building. A real understanding of just where this cooling down process takes place would serve to give a better understanding of what actually takes place in the building.

In rooms in the upper part of the building there must be a resultant flow of air from the center portion of the room toward the exposed glass and walls, and more particularly toward the cracks and crevices in the same. This will naturally result in a somewhat higher temperature near the glass and walls where it finds its exit than would be the case if no air flowed outward. Hence, some of the heat flowing outward through the glass and walls by transmission will be provided by the falling temperature of the outward flowing air as it approaches the exposed wall and window. While strictly speaking it may not be agreed that this represents heat addition to the room by exfiltration, it must result in a decreased heat loss from the air within the room. A true evaluation of this effect would be given by a properly integrated temperature of the air streams leaving through the cracks. No observations were made of these temperatures, but if they are assumed to be the glass surface temperatures, which were observed in the tests, then the negative heat loss by exfiltration given in Column E, Table 2, will pertain, giving an average balance of 103.7 per cent for all rooms on the 27th floor. Undoubtedly, the assumption that the air leaves the effective sphere of the room at glass temperature gives too high a value for heat gain.

Obviously, if there is a decrease in transmission loss from the 27th floor due to exfiltration, then, a similar increase in loss should pertain on the lower floors, where the air flows in the opposite direction.

A better comparison of the relation between the observed pressure drops through the windows and the theoretical stack effect, for various outside temperatures is shown in Fig. 7. THE GUIDE formula for pressure drop through windows at different elevations in a building, given previously, and based upon a 15 mph wind, is only meant to apply for a 70 F temperature drop, or for a zero deg outside temperature. These values are indicated for the three floors and a zero outside temperature. It should be noticed, however, that these values are for a 15 mph wind, while the average wind velocity resulting in the *measured* curves averages more nearly 7 mph. The *theoretical* values are for still air.

In further analysing the percentage of heat input based on the estimated heat loss, as given in Column I, it will be observed that room 707 and 2715, facing northwest or Grant Street, show the highest percentages, or 110.1 and 112.4, respectively, while room 705 and 2703, facing the northeast or Fourth Avenue, give the lowest percentages, or 91.7 and 93.9, respectively. The reason for these discrepancies cannot be found easily. In fact, actually they are not larger than might be expected as the result of uncontrolled variables encountered in the problem. However, since they follow exposure direction

rather than any other arrangement, it is safe to assume that the variation is not due to coincidence, but due to some unknown or improperly accounted for factors in the heat loss estimation, making these losses about 11 per cent too low for the Grant Street exposure and about 7 per cent too high for the Fourth Avenue exposure.

Improper evaluation of the effect of wind, or improper percentage evaluation of the effectiveness of solar radiation might be assumed to affect these discrepancies. However, since the estimated heat losses were based upon the observed wind velocity 3 ft outside of the window of each room tested, it is not probable that wind velocity resulted in the discrepancies. Based upon analysis of the data, it was estimated that the sun radiation entering the windows was 50 per cent effective in maintaining room temperatures during the period of the day when the rooms were under test, or from 8 a. m. to 10 p. m. This assumption was largely based upon the southwest exposures facing the direction of maximum sun effect. A closer analysis of the application of this assumption to the northeast and northwest exposures indicates that immediately following sunrise in the morning, and for an hour or more thereafter, radiation entered the windows on the northeast exposure. However, since most of this took place before the beginning of the test at 8 a. m. and resulted in only a negligible amount of heat gain after 8 a. m., little of it was credited in raising the temperature of these rooms. On the other hand, on the northwest exposure, the sun radiation began to enter the rooms at from 2 to 3 p. m., depending upon the time of the year, reached a maximum and receded to zero before the close of the test. It might be logical to assume that there is a lag in the effectiveness of the sun radiation so that all of the morning radiation becomes effective in maintaining the desired temperature in the rooms on the northeast exposure during the day, and that much less than 50 per cent is effective in rooms on the northwestern exposure before the close of the test. If it were assumed that all solar radiation entering the room on the northeastern exposure was effective and none of the radiation entering the rooms on the northwestern exposure was effective, the percentage values given in Column I would be changed to those in Column J, giving better agreement.

While the magnitude of these changes based on these assumptions is not of any great importance for the rooms studied in the Grant Building, they may assume some importance in finally evaluating general assumptions for the effectiveness of solar radiation in rooms of different exposures for design purposes. Thus for a building having exposures facing east, south and west, it may be ultimately proven desirable to assume different percentages for three exposures, with a considerable effect on the estimated heat requirement on sunny days. However, since the sun cannot be depended upon to help maintain desired temperatures under most severe heating conditions, it should be observed that sun radiation effects should not enter into the design of the maximum capacity of the heating equipment.

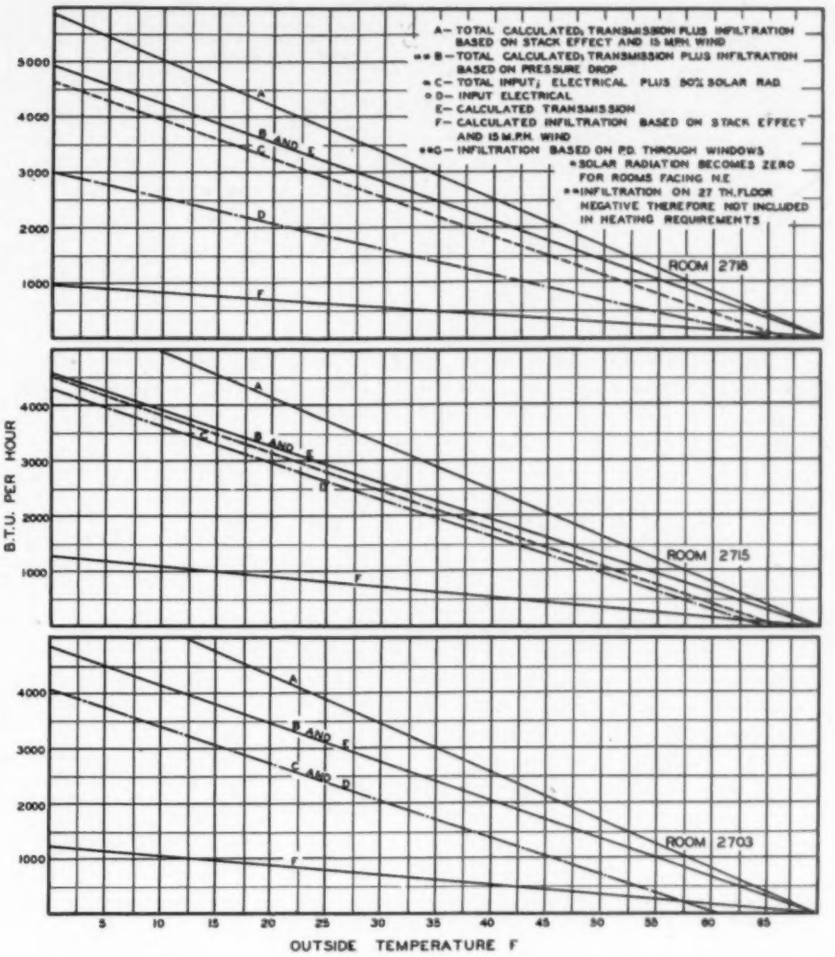

A— TOTAL CALCULATED; TRANSMISSION PLUS INFILTRATION BASED ON STACK EFFECT AND 15 MPH WIND
** B— TOTAL CALCULATED; TRANSMISSION PLUS INFILTRATION BASED ON PRESSURE DROP
* C— TOTAL INPUT; ELECTRICAL PLUS 50% SOLAR RAD
D— INPUT ELECTRICAL
E— CALCULATED TRANSMISSION
F— CALCULATED INFILTRATION BASED ON STACK EFFECT AND 15 M.P.H. WIND
**G— INFILTRATION BASED ON P.D. THROUGH WINDOWS
* SOLAR RADIATION BECOMES ZERO FOR ROOMS FACING N.E.
** INFILTRATION ON 27 TH. FLOOR NEGATIVE THEREFORE NOT INCLUDED IN HEATING REQUIREMENTS
ROOM 2718
ROOM 2715
ROOM 2703
B.T.U. PER HOUR
OUTSIDE TEMPERATURE F

Fig. 5—Relation between outside temperature and heat input to and loss from rooms on the 27th floor

The effect of elevation in the building on heat loss is further emphasized by the results of a test in which all the heat was turned off in the rooms 726, 1826 and 2718, at 8 a. m. The results of this test are plotted in Fig. 8, which gives the room temperatures, the temperatures 3 ft outside the windows, and the Weather Bureau temperatures throughout the day. These three rooms have the same exposure facing Third Avenue and, hence, are subject to the same solar radiation penetration through the window, which is also plotted. It will be observed that the rate of fall in room temperature was maximum for the 7th floor room and decreased with elevation in the building, and that an approximately constant difference in temperatures was maintained throughout the day. It is also of interest to observe the effect of solar radiation in raising the temperature of all three rooms during the time when the sun was effective and for some

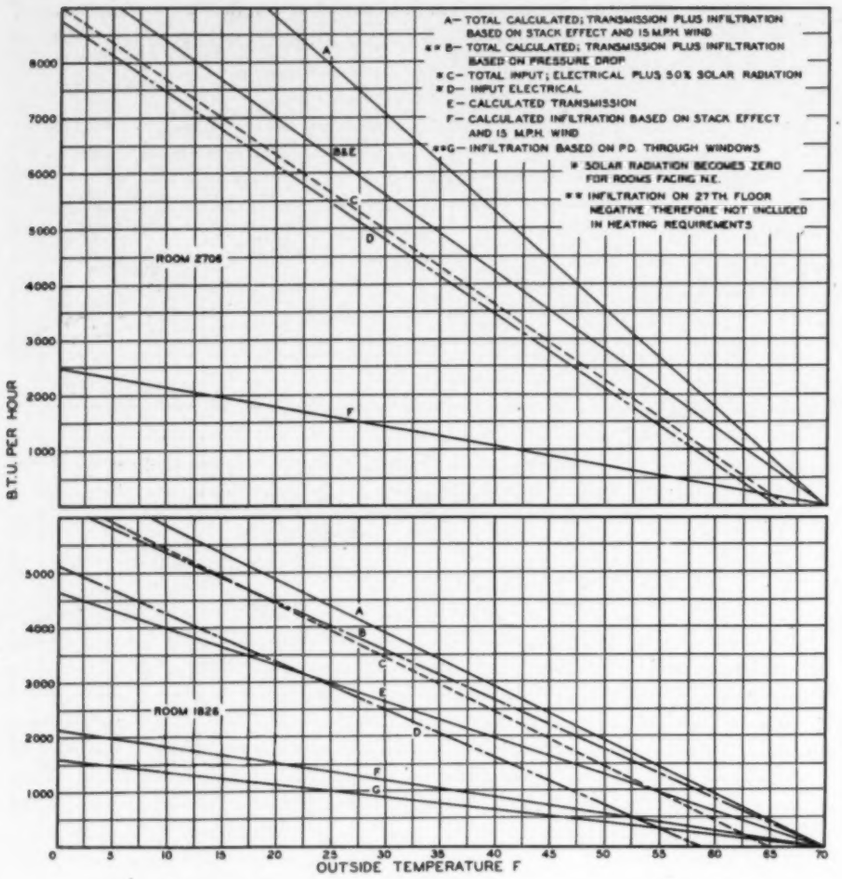

A— TOTAL CALCULATED; TRANSMISSION PLUS INFILTRATION BASED ON STACK EFFECT AND 15 M.P.H. WIND
* B— TOTAL CALCULATED; TRANSMISSION PLUS INFILTRATION BASED ON PRESSURE DROP
* C— TOTAL INPUT; ELECTRICAL PLUS 50% SOLAR RADIATION
* D— INPUT ELECTRICAL
E— CALCULATED TRANSMISSION
F— CALCULATED INFILTRATION BASED ON STACK EFFECT AND 15 M.P.H. WIND
** G— INFILTRATION BASED ON P.D. THROUGH WINDOWS
* SOLAR RADIATION BECOMES ZERO FOR ROOMS FACING N.E.
** INFILTRATION ON 27TH FLOOR NEGATIVE THEREFORE NOT INCLUDED IN HEATING REQUIREMENTS
ROOM 2706
ROOM 1826
B.T.U. PER HOUR
OUTSIDE TEMPERATURE F

Fig. 6—Relation between outside temperature and heat input to and loss from rooms 1826 and 726

time thereafter. It is of interest to note the rise of the air temperature 3 ft outside the windows with increased solar intensity.

Observations were made on the fall in temperature in rooms on the 4th and 30th floors following the turning off of steam at 9:30 p. m., and when the inside temperature had been maintained at approximately 74 F throughout the day. Between 9:30 p. m., and 8:00 a. m. when the steam was turned on, the average rate of fall in air temperature in the middle of a room on the 30th floor was 0.236 F per hour, while the rate of fall for the room similarly located on the 4th floor was 0.571 deg per hour. The results of tests plotted in Fig. 8, and the rate of fall in temperature for the rooms just referred to, are effective indications of the greater heat loss from the lower floors compared with the upper floors in the Grant Building.

The aeration of buildings due to the stack effect is influenced by a number of factors, including the height of the building and the elevation of a given room in the building, the tightness of the building between floors, or the resistance to the flow of air upwards. These are undoubtedly equally effective with the tightness of the windows on the different floors. Also, the cross-sectional area of the building at different elevations affects the pressure gradient. In buildings of the set-back type, where the cross-sectional area decreases with the height, the neutral zone may be expected to be considerably above the middle of the building. This effect is probably more a function of the area of stairways, elevator shafts and such avenues for air flow and the usage of the same, rather than the cross-sectional area. However, since these passage-ways are used by occupants in approximately inverse proportion to their elevation in the building, they may be expected to result in a considerable increase in resistance to flow with height, and therefore, an upward shift of the neutral zone. This is indicated in the *measured* curves in Fig. 7, where the average location of the neutral zone is considerably nearer the 27th than the 18th floor. Actually, the 19th floor is midway between the street level and the top floor served by elevators.

Because of the varied influences of building design, occupancy and operation, on the stack effect, it is necessary to obtain data on a large number of buildings before definite design assumptions can be reached. The curves in Figs. 4, 5 and 6 indicate a proportional average room heat demand as given by the electrical input plus 50 per cent of the solar radiation, corrected to room 1826 exposure, of 5,111, 4,435, and 2,997 Btu per hour for the 7th, 18th and 27th floors, which when plotted against elevation in the building give the relationship shown in Fig. 9. The results of a similar study in the Penobscot Building in Detroit[4] are also plotted. It will be observed that the points resulting from each study form a separate curve, showing different magnitudes of heat requirement and different

[4]Influence of Stack Effect on the Heat Loss in Tall Buildings, by Axel Marin, A. S. H. V. E. TRANSACTIONS, Vol. 40, 1934, p. 377.

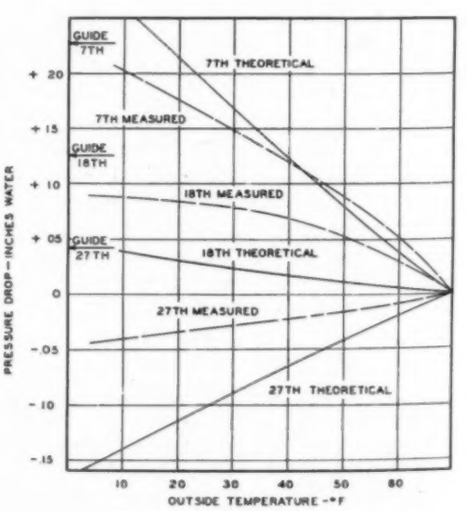


Fig. 7—Relation between outside temperature and pressure drop through the windows on the 7th, 18th, and 27th floors as measured, as based upon 100% chimney effect and no wind velocity, and as based on THE GUIDE formula for a 15 mile wind and a 70 F temperature difference

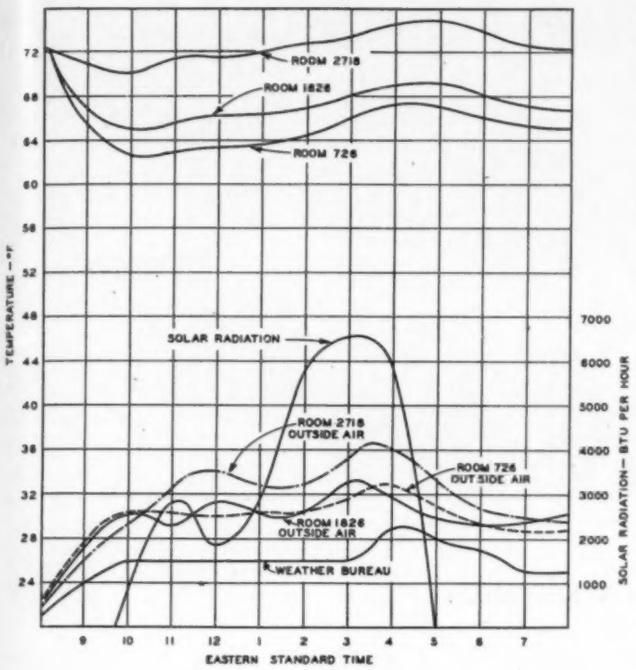


Fig. 8—Log of temperature change in the rooms, 3 ft outside of the windows, and as reported by the Weather Bureau after all the heat supply to the rooms was turned off at 8 a. m. Solar radiation penetration through the windows is also given

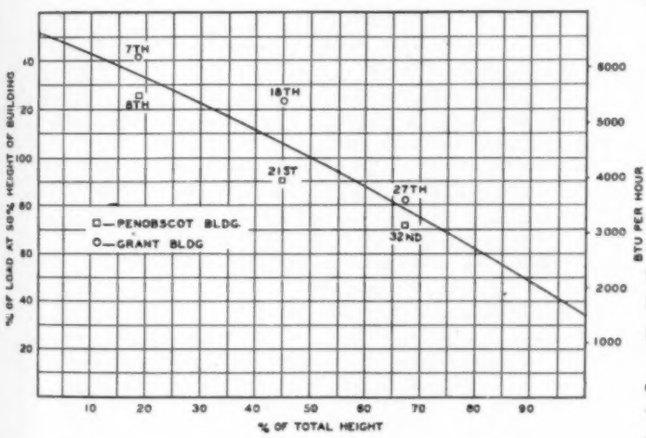


Fig. 9—Relation between the elevation in the building as expressed in per cent of the total height, and the heat required to maintain the temperature expressed in Btu per hour for the average room and in per cent of that required for rooms midway between the top and bottom of the building, as observed in the Grant Building and as reported† for the Penobscot Building, Detroit

†Grant Building 424 ft high, 38 stories; Penobscot Building 565 ft high, 47 stories.

characteristics of curvature. The different magnitude of heat requirement is a measure of the different exposures of the room studied in the two buildings. The difference in curvature, however, indicates a different relationship between height and heat requirement in the two buildings. The curves are similar in that considerably less heat is required in the upper floors, and the average curve drawn represents fairly well the variation in the percentage requirement in either building. However, it cannot be accepted with great confidence as applying to tall buildings in general, without additional observation in other buildings.

Some such general curve or formula is, however, desired as indicating the general relationship to be expected in buildings of this type, and it is hoped that relatively simple observations in a number of other buildings may be helpful in arriving at a general formula for the relation between elevation in sky-scraper type buildings to heat requirement, which may be used as a basis for design.

Summary and Conclusions

The study in the Grant Building indicates a considerable decrease in heat requirement with elevation in a building, indicating not only a complete absence of heat loss by infiltration in the upper floors, but also an actual decrease in the transmission loss due to the outflow of warm air through windows and walls.

Comparison of the relationship between estimated heat requirement and heat supplied in order to maintain the desired temperatures shows that, when due consideration is given to the actual pressure drop through the window and the effect of solar radiation, the actual input always ranged within 12 per cent, and usually a much smaller percentage, of the estimated requirement. The results of the study in the Grant Building and other similar studies are so varied as to indicate that results on more buildings must be obtained before a general formula for design purposes can be evaluated.

Explosions in Domestic Heating Furnaces May Be Minimized by Proper Firing Methods

Householders who experience irritation because of explosions in their heating furnaces may largely eliminate such explosions by the use of proper firing methods, says the U. S. Bureau of Mines, Department of the Interior. Careful regulation of the air supply in the furnace is the solution of the problem.

Explosions in domestic heating furnaces are of fairly common occurrence. They are particularly disagreeable when occurring in warm-air furnaces in which the joints are not tight, as the smoke and fumes are forced into the air ducts, and thus to the rooms of the house.

Such explosions usually occur shortly after firing a charge of fuel. Whether or not an explosion occurs will depend on the proportion of gas and air in the combustion space, and its temperature. Mixtures which have a large excess of air, or even a large deficiency of air, do not explode.

The first precaution against explosions when firing is to leave always a part of the live fuel exposed, if necessary, pushing some of the live fuel back in order to raise its level. The second is to insure an ample supply of air above the fuel bed, even leaving the firing door open a crack, if opening the slots does not eliminate explosions. The adjustment of the dampers to insure this air supply will differ with furnaces and fuels, but the supply of air above the fuel bed can be increased by leaving the ashpit damper closed, or nearly so, and regulating the rate of burning by the dampers in the stack.

Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS *is located*

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A. S. H. V. E. RESEARCH

A Page of News Notes and Comment

By Brewster S. Beach*

RAILROAD AIR CONDITIONING RESEARCH MAKING PROGRESS

L. W. Wallace, Association of American Railroads

Encouraging progress is reported by the Committee on Research in planning a program of cooperative research with the *Association of American Railroads.* L. B. Miller, representing the committee, and F. C. Houghten, director of the Society's Laboratory, conferred recently in Chicago with L. W. Wallace of the railroad association.

Among the subjects considered for this research, are odors, high temperature radiation from hot glass and walls due to the high effective wind velocity and sun radiation on the outside of cars. Also direct radiation through glass, insulation of car walls, methods of bringing air into the occupied zone of the car and its distribution, as well as the problem of filtering the air.

Much of this work, the committee feels, can be correlated with existing activities of technical committees now studying these problems. Among those who have interested themselves in this work are Prof. F. B. Rowley, Dr. T. R. Crowder, A. E. Stacey, Jr., and J. H. Van Alsburg, the two latter being members of the Committee on Research. Mr. Wallace who is in general charge of the work for the railroad association is assisted by Prof. A. I. Brown, of Ohio State University. Frank Murphy, who is in charge of the engineering development on air conditioning for the Pullman Company, is expected to have an important part in the program when final details are completed. Chairman Danielson will shortly announce the formation of a technical committee on Transportation Air Conditioning to direct this research.

STUDY HEAT GAIN OF BUILDINGS

The increasing trend to widespread use of air conditioning in large buildings particularly office buildings and public institutions is responsible for new research to be undertaken by the A. S. H. V. E. in cooperation with the *Air Conditioning Manufacturers Association,* involving a special investigation of the heat gain of such buildings. A committee is in process of formation and preliminary work is in progress.

J. H. Walker, former chairman of the Guide Publication Committee and member of the Committee on Research, will direct the work, which for the most part will be carried out through the Research Laboratory in Pittsburgh under F. C. Houghten. The first part of the program contemplates studies of the heat gain in some of the large buildings in Washington, D. C.

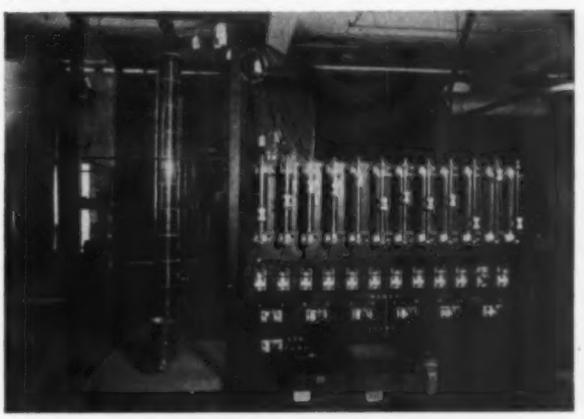
Among those interested in this work are W. H. Carrier, D. E. French, Carrier Corporation, who will coordinate *A. C. M. A.* activity, H. F. Hutzel, Kelvinator Corporation, F. H. Faust, General Electric Co., R. M. Stickeleather, B. F. Sturtevant Co., S. P. Eagleton, engineer, Washington, and A. E. Stacey, Jr.

Test apparatus is being developed by the Research Laboratory to include test boxes and panels permitting a number of tests to be made over a comparatively short period in order that data may be secured during the remaining summer months.

*Director, Information Service, Committee on Research.

IMPORTANT RESEARCH ON HEAT TRANSFER ACROSS AIR SPACES

Especially pertinent to the activity of the Committee on Research on problems of insulation was the paper delivered at the Swampscott meeting of A. S. H. V. E., by Prof. Gordon Wilkes, member of the Insulation Committee and Carl M. F. Peterson, entitled Radiation and Convection Across Air Spaces in Frame Construction.



View of apparatus used to determine variation of convection with height

Messrs. Wilkes and Peterson, respectively professor and instructor in mechanical engineering at Massachusetts Institute of Technology, announced new experimental data in regard to the rate of heat transfer across full sized air spaces in various positions bounded by surfaces that are both good and poor reflectors of heat radiation.

Their studies have added a new chapter to the understanding of the insulating effect of ordinary air spaces such as that between the studs in frame construction, and a new method of measuring the rate of heat transfer across such spaces. These experiments were conducted in an air space 8 ft high, 2 ft 8 in. wide, and 3⅝ in. across and were intended primarily to test the effect of heat transfer across spaces not in a vertical position.

CURRENT ACTIVITIES

Two new Research Representatives have been appointed by local chapters. C. W. May of Seattle represents the Pacific Northwest Chapter at that point and D. D. Zink of Kansas City will act for the Kansas City chapter. Both are consulting engineers.

The following new Committee on Effect of Water on Roofs was announced this month: Chairman, A. B. Snavely, Hershey Chocolate Corp., Hershey, Pa.; William Lynch Murray, Harrisburgh, Pa.; C. S. Reeve, technical director, The Barrett Company, New York; M. R. Beasley, Bird & Son, East Walpole, Mass.; Prof. E. R. Queer, Pennsylvania State College; E. H. Hyde, technical department, Koppers Co., Pittsburgh, Pa., and E. T. Selig, Jr., Fuel Savers Inc., Harrisburgh.

Correlating Thermal Research

As a part of the efforts of the A. S. H. V. E. Research Laboratory to correlate research in thermal engineering carried on by the many institutions engaged in such work, and to disseminate the published results of such studies together with other reports of progress in this field, and in order to make this information available to the membership of the Society, there will be published monthly on this page a limited number of brief abstracts of articles which it is believed will be of interest to all concerned. For more complete lists address the Librarian, A. S. H. V. E. Research Laboratory, U. S. Bureau of Mines Experiment Station, Pittsburgh, Pa.

F. C. Houghten, *Director.*

W. A. Danielson, *Chairman,*
COMMITTEE ON RESEARCH

• The Ill Effects of Heat Upon Workmen, by J. H. Talbott and others. *The Journal of Industrial Hygiene and Toxicology,* vol. 19, no. 6, June, 1937, pp. 258-274. Report of clinical and chemical data from two groups of men workers suffering from over exposure to heat and the clinical syndromes associated with this exposure. Salting of drinking water suggested as possible preventative of heat disorders.

• Design and Operation of Exhaust Ventilation Systems. *Heating and Ventilating,* vol. 34, no. 5, May, 1937, pp. 47-55. Fundamentals relating to the design and operation of exhaust systems by the *American Standards Association.* Incomplete report on fundamental concepts and data available for design of exhaust systems.

• Heat Insulation; the Selection of Suitable Materials for Various Purposes, by J. S. F. Gard. *Journal of the Institute of Fuel,* vol. X, no. 52, April, 1937, pp. 223-250. Bibliography. Paper correlates existing knowledge of heat insulation, gives references to literature, presents results of author's experiences and indicates points to be considered in selecting and installing insulation.

• The Use of an Elbow in a Pipe Line for Determining the Rate of Flow in the Pipe, by Wallace M. Lansford. Bulletin no. 289, Engineering Experiment Station, University of Illinois, Urbana, Ill. 36 pages. Description of method of using an elbow in a pipe line to measure the flow of fluid through the pipe. Meter must be calibrated where used. 90 deg elbow using water for fluid for accurate results. Tables are available for meter which would be accurate in any ordinary case with an error of less than 10 per cent.

• Size Distribution of Ceramic Powders as Determined by a Particle Air Analyzer, by Paul S. Roller. *Journal* and *Ceramic Abstracts, American Ceramic Society,* vol. 20, no. 5, May, 1937, pp. 167-174. Data obtained with a new system using air as a fluid for analytical separation of microscopic-size particles where a dynamic relationship exists between the powder sample and the air jet.

• (Economic Production of Heat and the Necessary Refrigeration for Heating and Cooling Residences.) Production Economique de la Chaleur et du Froid Necessaires au Chauffage et au Rafraichissement des Habitations, by Ch. Boileau. *Chaleur et Industrie,* no. 203, 18 annee March, 1937, pp. 129-237.

• Cost Analysis of Wood Frame and Stucco House, by Paul C. Ulmer. Purdue Housing Research Project. *American Builder and Building Age,* vol. 59, no. 5, May, 1937, pp. 65-70 and 138-148. Detailed description of houses with construction cost summary and in detail. Individual items for labor and material. House is a wood frame stucco house of 6 rooms and bath without basement.

• Essential Features of Heating Systems, by P. E. Mohn. The *Master Plumber,* vol. 7, no. 5, May, 1937, pp. 11-19. Elementary discussion of essential features of warm air, steam, vapor and hot water heating systems. Table of percentage of these systems used in U. S. and in State of Illinois, taken from 1934 Bureau of Commerce Real Property inventory. (to be continued)

• The Reynolds' Number Factor and the German Flow Meter Standard, by Lyman M. Van Der Pyl. *American Gas Association Monthly,* vol. 19, no. 4, April, 1937, pp. 155. Discussion of report of *American Gas Association* measurement committee report no. 2, which states that the discharge coefficient of an orifice decreases slowly as the Reynolds' number increases. *German Society of Engineers* standard states the discharge is constant above a certain value of the Reynolds' number.

• Demand for Cooling Water at Wichita Exceeds Underground Supply. *Engineering News Record,* vol. 18, no. 20, May, 1937. Discussion of water supply for air conditioning during summer months. In Wichita, Kansas, water is obtained from individual wells. 900 sq ft floor space required 312,000 gal of water for July cooling.

• Air Conditioning in Industry. Improved Efficiency of Workmen. *Heating & Ventilating,* vol. 34, no. 5, May, 1937, pp. 57-58. Description of various incidents of effect of air conditioning on the workmen from the standpoint of improved efficiency, reduction of sickness and lowering of the accident rate.

• Pipe Corrosion and Coatings; Survey by Observation, by Erick Larson. *American Gas Journal,* vol. 146, no. 5, May, 1937, pp. 47-50 and 91-94. Discussion of soil conditions which affect corrosion of bare or covered pipe. Data are given for soil temperature and depth, also effect of moisture on corrosion.

• Solar Energy and Its Use for Heating Water in California, F. A. Brooks. Bulletin no. 602, Agricultural Experiment Station, U. of Calif., Berkeley, Calif., 64 pages. Bulletin discusses the available solar energy in Calif., and the use and construction of solar water heater systems.

• Oil Saving of $9 to $160 by Insulation, by G. L. Larson. *Fuel Oil,* vol. XV, no. 12, June, 1937, p. 23. By use of data in A. S. H. V. E. GUIDE author shows value of insulation in reducing fuel used yearly, also decrease in original cost of the heating system in well insulated residence.

• Better Air, Better Work, William H. Easton. *National Safety News,* vol. 35, no. 5, May, 1937, pp. 21-22. General discussion of value of air conditioning in office buildings and other places where people work, in terms of health and efficiency of the workers.

• Corrosion of Metals under High Pressure, by F. H. Rhodes and J. M. Clark. *The Iron and Coal Trades Review,* vol. XXXIV, no. 3,610, May 7, 1937, p. 851. Report of tests on iron and other metals subjected to 210 kg per sq cm in a humid atmosphere with added CO_2. Corrosion was found to be a linear function of gas pressure.

• Odor Control Methods, by F. H. Munkelt. *Refrigerating Engineering,* vol. 33, no. 6, June, 1937, pp. 371-372. Discussion of odor removal by activated carbon manufactured from cocoanut shells. This activated carbon absorbs hydrocarbons and organic gases but very little water vapor. List of more important odors and concentrations at which each becomes noticeable. Odor removal equipment should, for economy, be placed in recirculation duct. Carbon should be reactivated every 3 to 5 years.

• Viscosity and Reynolds' Number, by Dr. J. R. Zwickl. *Refrigerating Engineering,* vol. 33, no. 6, June 1937, pp. 389-393. Formulae derived for Absolute Viscosity, Dynamic Viscosity and Kinematic Viscosity and the proper transformation factors which must be applied in order to express correctly a given viscosity condition. Also derivation of Reynolds' Number and conditions for its use.

• Modern Ozone Water Treatment Works, by A. Karsten. *Technisches Gemeindeblatt,* Germany, vol. 39, 1936, p. 58. Description of apparatus for ozone treatment of water supplies in Yawata, Japan, Bilbao, Spain; Paris and other cities. Results obtained are bacteriologically and hygienically satisfactory.

The Inspiration of Society Membership

W. T. Jones

The Membership Committee invited me to write an article for the Journal on the subject of, Why Have You Continued Your Interest and Activities in the Society Long After You Have Held the Highest Honors the Society Can Bestow. As most of the older members know why our Society continues to hold the interest of those who have been active, I am going to address this article particularly to those members who have recently joined the Society, or who have belonged only a few years.

As I look back upon my early years in the Society, I think that perhaps my attitude then was typical of that of many of our younger members now. I joined the Society in 1915, because of a desire to obtain the latest authentic engineering data, which the Society was producing, and also to enhance my standing with my employers, for being progressive enough to affiliate with the engineering society serving the industry. For several years I took no part in Society activities, and while being vaguely conscious of the fact that there was an organization in New York functioning to operate affairs, I saw no particular reason for concerning myself about it. I was just another member, without any particular curiosity as to what made the wheels go around. I felt that Society membership was worthwhile due to the feeling of satisfaction I had in belonging to the same Society as the recognized outstanding leaders in the industry.

During my early years in the Society, my Chapter was not in a very flourishing condition, but in about 1920 an effort was made to increase activities and the Chapter began to take on life. I became active in Chapter affairs, and somewhat to my surprise, in 1925 I was nominated and elected to the Council. I speak of these years as they have a bearing on some points I wish to emphasize later in this article.

I started my service on the Council with no knowledge of Society management, and with no particular amount of enthusiasm. I had heard that the Society was operated by cliques, and that some of the governing group were there simply to advance their personal interests. You see, the ever present suspicion monger was doing his work even in those days.

When I started my term on the Council, it did not take me long to find out that there were no cliques in Society management. Instead, I found a fine group of men, men of character and outstanding ability, devoting an unbelievable amount of time and effort with only one object in mind—the good of the Society. By that time the Research Laboratory was well established, although suffering severe growing pains, and The Guide was three years old, demanding as much time and care as the usual infant of that age. Due to the financial skill of some of our great officers of that period, the Society was emerging from the red into the black.

On that Council I found men willingly assuming burdens that demanded an immense amount of effort. I was amazed at the spirit of these fellow members, who were devoting so much of their ability to the upbuilding of the Society.

To mention one item—I wonder how many of our members realize the stupendous task of producing The Guide without spending money for editorial service. I saw time and ability freely devoted to Society interests that would have cost thousands upon thousands of dollars if the Society had paid for it. This work was not confined to officers of the Society, but our membership freely responded when called upon to contribute their efforts to the good of the cause. Officers and members were not only going into their own pockets for money to support the Research Laboratory, but they were assuming the thankless and disagreeable task of going out in the field to raise the necessary funds to carry on the work. Our membership was solidly back of the research program, which was producing invaluable results in determining fundamental data, which are authoritative in the industry today. The business affairs of the Society were conducted as one would expect to find them in an efficient, modern, industrial enterprise.

These things and many more of like nature caused me to realize that this Society of ours is really a great organization. The spirit of the men, of whom I have referred, has existed since the Society was started, and is present today as strong as ever. Call the roll of the leaders in the industry since 1895, and you will find them all identified with the Society. Most of them have contributed, or are contributing, much of their ability in making the Society the outstanding engineering organization it is today.

As I entered upon my service on the Council, and saw the work my associates were doing, it was indeed an inspiration to me. I plunged into the work, eagerly seizing any opportunity to contribute my small bit. The Society and its welfare became an important factor in my life. I consider myself most fortunate in having had the privilege of working with the men with whom I have served in Society activities. Mistakes—yes, I have seen and have taken part in them; mistakes in judgment, but all of them honest mistakes. Some errors in judgment, and some things not errors, have been criticized by some of our members, as if ulterior motives were involved, but in my ten years of service as an officer of the Society, I have never seen a decision made where the motive could be questioned. I have seen many efforts by members of the Society and others to use the Society to promote their commercial interests, but usually these schemes are transparent and are easily frustrated by an alert Council.

The inspiration of working with the leaders of the industry; the broadening of acquaintance, and the pleasure of seeing acquaintance ripen into friendship; the exchange of ideas; the fresh viewpoint of our own business and the new ideas we always bring home from one of our meetings; the feeling of satisfaction we have in the knowledge that, as part of our dues is allocated to research, each of us is contributing to the upbuilding of our profession; these, the intangibles, are the really important benefits of Society membership.

No member can begin to appreciate the full value of Society membership unless he attends the Annual and Semi-Annual Meetings. After the meeting in St. Louis, I heard a Chapter President say, "This is the first Annual meeting of the Society I have attended, although I have been to many meetings of other engineering societies, to which I belong. I was impressed at St. Louis with the friendly atmosphere that prevailed at the sessions, and I enjoyed our Society meeting more than any other I have ever attended." This statement of a Chapter President expresses the reason why the older Society members continue to go year after year to the meetings.

Almost all of the Past Presidents of the Society retain their interest in Society affairs. Although, in the words of a famous man, our only job now, out in the pasture, is to sit down and watch our arteries harden, we are just as keenly interested in the Society's progress as ever. It is fitting that we should be out of the active picture and give way to other and perhaps better men; we have had our day, and our record is written, but you will find us on the firing line if called upon, and you can rest assured that our interest will always be to see this grand old Society of ours scale still greater heights.

NEWS OF LOCAL CHAPTERS

OFFICERS OF LOCAL CHAPTERS—1937

ATLANTA: *Organized,* 1937. *Headquarters,* Atlanta, Ga. *President,* E. W. KLEIN, 152 Nassau St., N. W. *Secretary,* C. T. BAKER, 713 Glenn St., S. W.

CINCINNATI: *Organized,* 1932. *Headquarters,* Cincinnati, O. *Meets,* Second Tuesday in Month. *President,* I. B. HELBURN, 610 Chamber of Commerce Bldg. *Secretary,* H. E. SPROULL, 1005 American Bldg.

ILLINOIS: *Organized* 1906. *Headquarters,* Chicago, Ill. *Meets,* Second Monday. *President,* L. S. RIES, 960 East 58th St. *Secretary,* C. E. PRICE, 6 N. Michigan Ave.

KANSAS CITY: *Organized,* 1917. *Headquarters,* Kansas City, Mo. *Meets,* Second Monday in Month. *President,* A. H. SLUSS, 827 Mississippi Ave., Lawrence, Kan. *Secretary,* GUSTAV NOTTBERG, 914 Campbell St.

MANITOBA: *Organized,* 1935. *Headquarters,* Winnipeg, Man. *Meets,* Fourth Thursday. *President,* D. F. MICHIE, 5B, 553 Wardlaw Ave. *Secretary,* C. H. TURLAND, 325 Centennial St.

MASSACHUSETTS: *Organized,* 1912. *Headquarters,* Boston, Mass. *Meets,* Second Tuesday in Month. *President,* JAMES HOLT, Massachusetts Institute of Technology, Cambridge, Mass. *Secretary,* JOHN TURNER, 285 Columbus Ave.

MICHIGAN: *Organized,* 1916. *Headquarters,* Detroit, Mich. *Meets,* First Monday after the 10th of the Month. *President,* F. J. FEELY, 950 Trombley Rd., Grosse Pointe Pk. *Secretary,* G. H. TUTTLE, 2000 Second Ave.

WESTERN MICHIGAN: *Organized,* 1931. *Headquarters,* Grand Rapids, Mich. *Meets,* Second Monday in Month. *President,* L. G. MILLER, Mich. State College, E. Lansing, Mich. *Secretary,* E. I. ADAMS, 115 So. Pine, Lansing, Mich.

MINNESOTA: *Organized,* 1918. *Headquarters,* Minneapolis, Minn. *Meets,* Second Monday in Month. *President,* N. D. ADAMS, 220 Second Ave. S. W., Rochester, Minn. *Secretary,* J. E. SWENSON, 800 Hennepin Ave.

MONTREAL: *Organized,* 1936. *Headquarters,* Montreal, Que. *Meets,* Third Monday. *President,* G. L. WIGGS, University Tower. *Secretary,* C. W. JOHNSON, 630 Dorchester St., W.

NEW YORK: *Organized,* 1911. *Headquarters,* New York, N. Y. *Meets,* Third Monday in Month. *President,* G. E. OLSEN, 101 Park Ave. *Secretary,* T. W. REYNOLDS, 100 Pinecrest Dr., Hastings-on-Hudson, N. Y.

WESTERN NEW YORK: *Organized,* 1919. *Headquarters,* Buffalo, N. Y. *Meets,* Second Monday in Month. *President,* B. C. CANDEE, 19 Tremont Ave., Kenmore, N. Y. *Secretary,* W. R. HEATH, 119 Wingate Ave.

NORTHERN OHIO: *Organized,* 1916. *Headquarters,* Cleveland, O. *Meets,* Second Thursday in Month. *President,* PHILIP COHEN, 401 East Ohio Gas Bldg. *Secretary,* C. A. MCKEEMAN, Case School of Applied Science.

OKLAHOMA: *Organized,* 1935. *Headquarters,* Oklahoma City, Okla. *Meets,* Second Monday. President, F. X. LOEFFLER, 1604 N. W. Fifth St. *Secretary,* E. W. GRAY, Box 1498.

ONTARIO: *Organized,* 1922. *Headquarters,* Toronto, Ont. *Meets,* First Monday in Month. *President,* G. A. PLAYFAIR, 97 Jarvis St. *Secretary,* H. R. ROTH, 57 Bloor St. W.

PACIFIC NORTHWEST: *Organized,* 1928. *Headquarters,* Seattle, Wash. *Meets,* Second Tuesday in Month. *President,* S. D. PETERSON, 473 Colman Bldg. *Secretary,* D. C. GRIFFIN, Orpheum Bldg.

PHILADELPHIA: *Organized,* 1916. *Headquarters,* Philadelphia, Pa. *Meets,* Second Thursday in Month. *President,* L. P. HYNES, 240 Cherry St. *Secretary,* C. B. EASTMAN, 530 Brookview Lane, Brookline, Upper Darby, Pa.

PITTSBURGH: *Organized,* 1919. *Headquarters,* Pittsburgh, Pa. *Meets,* Second Monday in Month. *President,* M. L. CARR, P. O. Box 1646. *Secretary,* T. F. ROCKWELL, Carnegie Inst. Tech.

ST. LOUIS: *Organized,* 1918. *Headquarters,* St. Louis, Mo. *Meets,* First Tuesday in Month. *President,* G. W. F. MYERS, 3947 W. Pine Blvd. *Secretary,* D. J. FAGIN, 1344 Woodruff Ave.

SOUTHERN CALIFORNIA: *Organized,* 1930. *Headquarters,* Los Angeles, Calif. *Meets,* Second Tuesday in Month. *President,* E. H. KENDALL, 1978 S. Los Angeles St. *Secretary,* J. F. PARK, 1234 South Grand.

TEXAS: *Organized,* 1936. *Headquarters,* College Station, Texas. *President,* F. E. GIESECKE, Texas A. & M. College. *Secretary,* W. H. BADGETT, Texas A. & M. College.

WASHINGTON, D. C.: *Organized,* 1935. *Headquarters,* Washington, D. C. *Meets,* Second Wednesday in Month. *President,* W. A. DANIELSON, 2336 Munitions Bldg. *Secretary,* M. D. KICZALES, 3000 Connecticut Ave., N. W.

WISCONSIN: *Organized,* 1922. *Headquarters,* Milwaukee, Wis. *Meets,* Third Monday in Month. *President,* J. H. VOLK, 1906 W. St. Paul Ave. *Secretary,* H. C. FRENTZEL, 3000 W. Montana St.

Golden Gate Chapter Organized in San Francisco

A charter was granted by the Council of the Society, June 23, for the organization of a Golden Gate Chapter of the A.S.H.V.E. Members located in northern California and the State of Nevada will be eligible to join.

To further the organization of the Chapter, a preliminary meeting was held at the Commercial Club, San Francisco, Calif., at noon on May 26, 1937, with the following men present: B. M. Woods, R. A. Hudson, W. E. Leland, A. J. Bouey, G. J. Cummings, L. H. Cochran, and J. I. Krueger; also the following men who have applied for membership, B. F. Raber, E. C. Cooley, N. H. Peterson, C. S. Ames, V. H. Cherry, T. A. Marshall, W. H. Holbrook, C. E. Bentley, G. M. Simonson, G. G. Harrison, W. W. Cockins, F. W. Hutchinson, and E. H. Goins.

The meeting was called to order by G. J. Cummings and nominations for a chairman pro-tem were declared in order, and resulted in the election of Prof. B. M. Woods by acclamation. Professor Woods immediately called the meeting to order and appointed a Nominating Committee to select future officers for the proposed Chapter, consisting of R. A. Hudson, chairman, W. E. Leland and A. J. Bouey.

The following slate of officers was presented by the Nominating Committee and Mr. Cummings, secretary pro-tem, was instructed to send ballots to the members as soon as a charter had been granted:

President—B. M. Woods
Vice-President—L. H. Cochran
Secretary—G. J. Cummings
Treasurer—C. E. Bentley
Board of Governors—A. J. Bouey, H. S. Haley, G. M. Simonson.
Committee on Constitution and By-Laws—V. H. Cherry, C. S. Ames, J. I. Krueger.
Committee on Membership—G. J. Cummings, R. A. Hudson, W. E. Leland, N. H. Peterson.

The meeting carried on a general discussion of the purposes of the organization and future meetings are to be called at the discretion of the chairman.

Fans, Use of Purchased Steam and Railway Air Conditioning Discussed by Kansas City Chapter

May 10, 1937. Pres. L. R. Chase presided at a dinner and meeting of Kansas City Chapter held at the Newbern Hotel at 6:15 p. m. and attended by 21 members and guests.

President Chase announced the formation of an A. S. H. V. E. Chapter at Atlanta, Ga.

The committee previously appointed to select a Chapter research representative reported that D. D. Zink was named as the Kansas City representative and Secy. F. J. Dean, Jr., was instructed to advise Mr. Zink and W. A. Danielson, chairman of the Society's Committee on Research, of this action.

C. A. Weiss, chairman of the Nominating Committee, announced that the following members had been recommended for nomination to offices of the Kansas City Chapter for the following year:

President—Prof. A. H. Sluss.
Vice-President—A. L. Maillard.
Secretary—Gustav Nottberg.
Treasurer—J. E. Matthews.
Board of Governors—L. R. Chase, W. L. Cassell, M. A. Disney.

As no further nominations were offered the Chapter unanimously elected the candidates into office for the following year.

Mr. Chase opened a discussion of plans for the annual Spring social meeting, and appointed E. K. Campbell as chairman of a committee to make arrangements for this party. Other members appointed to serve with Mr. Campbell were L. A. Stephenson, J. N. Sawyer, K. M. Stevens and E. K. Campbell, Jr.

E. K. Campbell reported on the possibility of the A. S. H. V. E. holding a meeting in Kansas City and advised that he would continue his investigation of the matter.

Mr. Chase introduced the speaker of the evening, T. H. Anspacher, who spoke on Testing, Rating and Application of Fans. Mr. Anspacher outlined the various types of available fans, giving a brief summary of the general uses of each, and then discussed briefly the history of various types of fans dating back to the original straight wooden bladed centrifugal type. Mr. Anspacher pointed out how fans had been perfected and in what ways future improvements could be expected. He discussed the wide variety and scope of application of present day blower equipment and distributed pictures showing the elaborate nature of modern fan testing equipment.

The subject was of fundamental interest to the audience and was followed by a lively discussion prior to the adjournment of the meeting.

April 13, 1937. Thirty-six members and guests of Kansas City Chapter met at the Newbern Hotel for a dinner and meeting which was featured by the presence of D. S. Boyden, President of the Society.

Pres. L. R. Chase presided and E. K. Campbell reported on the possibility of the A. S. H. V. E. holding one of their meetings in Kansas City.

L. A. Stephenson spoke of the *A. S. R. E.* meeting to which members of the Kansas City Chapter were invited and he reviewed the topics discussed.

The report of the Nominating Committee was deferred until the May meeting.

D. D. Zink, chairman of the Membership Committee, gave a brief report of activities.

President Chase discussed a letter from the A. S. H. V. E. Committee on Research requesting that a chapter research representative be appointed and Mr. Chase named A. L. Maillard chairman of a committee to select such a representative from the chapter. N. W. Downes and W. L. Cassell were appointed to serve on this committee with Mr. Maillard.

President Chase introduced the speaker of the evening, D. S. Boyden, Boston, Mass., president of the A. S. H. V. E.

In his talk Colonel Boyden presented an outline of the activities of the Society since its organization in 1894 and he discussed the topics of research, and publications, as well as the financial status of the Society.

In a talk on the Economic Use of Purchased Steam, President Boyden pointed out the general extent of steam waste and he presented an interesting discussion on the use of a condensate recovery system for hot and cold water use from a district steam supply system. Slides were shown giving the economical advantages of such an arrangement and indicating the relative purity of water obtained from this source. The subject was new to many of the members of the Kansas City Chapter and held the interest of all present.

President Boyden closed his presentation by extending an invitation to members to attend the Semi-Annual Meeting of the Society to be held at Swampscott, Mass., June 24-26.

After a short discussion the meeting adjourned according to the report of Secy. F. J. Dean, Jr.

March 8, 1937. Pres. L. R. Chase presided at a meeting of the Kansas City Chapter held at the Newbern Hotel when 25 members were present for dinner and two additional members arrived in time to hear the speaker of the evening.

A committtee of the following chapter past-presidents was appointed by President Chase to nominate officers for the coming year: C. A. Weiss, chairman, E. K. Campbell, Carl Clegg and L. A. Stephenson.

President Chase turned the meeting over to Prof. A. H. Sluss who introduced the speaker, Walter Bowenstengel, division engineer, of the Atchison, Topeka & Santa Fe Railway. Mr. Bowenstengel gave a review of the existing methods of air conditioning railroad cars dividing his discussion into two main divisions covering types of refrigeration in use and types of distribution in use. He pointed out that the Santa Fe system had standardized on steam jet refrigerating equipment principally because of the availability of steam supply on moving trains and at terminals, and because there was less loss of efficiency on moving trains at all speeds with this type of equipment.

He showed charts and diagrams of a steam ejector system on a dining car and traced the refrigeration and air distribution cycles, giving practical data on the maintenance, requirements and practices.

Golf Outing Enjoyed by Philadelphia Members

May 13, 1937. The annual golf outing of the Philadelphia Chapter was held at the Aronomink Golf Club, Newtown Square, Pa. The weather being excellent, 67 members and guests played golf in the afternoon. In spite of the heavy shower which inconvenienced a few of the late starters, the totals of the scores showed that nearly everyone examined the course thoroughly and got plenty of exercise.

Dinner was served in the grill room of the Club to 87 members and their guests, and during the meal an accordion player furnished music.

Following dinner Pres. L. P. Hynes read the committee appointments for the coming year and called on H. H. Erickson, who urged all members to attend the Semi-Annual Meeting of the Society at Swampscott, Mass.

W. P. Culbert, who had consented to take care of the golfing activities, awarded the golf trophies. A total of 6 players was tied for the kicker's handicap and the following were decided as the winners: first—G. W. Barr, second—J. Bennett, third—R. A. Naegely, fourth—R. W. Hallowell, fifth—Edward Wood, and sixth—William Gorton. The award for the high gross was made to L. H. Plum.

The formal meeting was adjourned by President Hynes but the members lingered to enjoy the Card Room and other entertainment facilities of the club according to the report of Secy. C. B. Eastman.

Ontario Chapter Elects Officers at Annual Meeting

May 3, 1937. Ontario Chapter held its annual meeting at the Royal York Hotel, Toronto, with 46 members present.

Following dinner Pres. Thomas McDonald called upon W. R. Blackhall to report on the University of Toronto award. Mr. Blackhall stated that the Ontario Chapter had selected C. E. Beynon, who wrote on the Properties and Economic Possibilities of Heat Insulation for Buildings, as the recipient of the first prize for the best thesis. The second and third awards were given to Mr. DeMaio and W. R. Trusler for the work which they had done.

J. W. O'Neill stated that the Weather Committee had collected data from the principal cities in Canada and it was anticipated that the committee will soon have design data on dry- and wet-bulb temperatures for THE GUIDE. In order that data may be compiled in regard to the use of city water for summer cooling, city water temperatures throughout Canada are being obtained.

President McDonald called attention to the A.S.H.V.E. Semi-Annual Meeting at Swampscott, Mass., and also announced the formation of a local chapter in Atlanta, Ga.

Secy. H. R. Roth read the report of the treasurer and the auditor's report, which were accepted.

It was the desire of the meeting that the chapter fee remain at $3.00 and it was voted that the Board of Governors decide the appropriation for stenographic fees for the coming year.

It was the consensus of the meeting to hold their sessions at the Royal York Hotel during the coming year and that the Board of Governors take up the matter of chapter relationship and the forwarding of notices to other A.S.H.V.E. Chapters.

It was moved by D. J. MacDonald and seconded by A. J.

Dickey that the Board of Governors approve expenses as they see fit.

It was announced by O. L. Maddux, chairman of the Membership Committee, that 17 new members had been obtained during the 1936-37 season.

Reports for the Greeters Committee and the Paper Committee were given by W. P. Boddington and C. Tasker respectively.

President McDonald mentioned that during the past year the chapter averaged 78 members and guests at each meeting.

Secretary Roth read the following report of the Nominating Committee for officers for the coming years:

President—G. A. Playfair.
Vice-President—H. B. Jenney.
Secretary—H. R. Roth
Board of Governors—H. D. Henion, J. W. O'Neill, O. L. Maddux, Thomas McDonald.

It was moved by Mr. McDonald, seconded by S. W. Alexander, and carried, that M. W. Shears cast an unanimous vote for the election of officers as recommended by the Nominating Committee.

President McDonald turned the gavel over to the new president, G. A. Playfair, and Mr. Maddux expressed appreciation on behalf of the chapter to Mr. McDonald for the splendid manner in which he officiated as president during the past year.

The meeting was then turned over to E. R. Gauley who was in charge of the entertainment for the evening.

Symposium on Atmospheric Pollution Interests Pittsburgh Chapter

May 10, 1937. The meeting of Pittsburgh Chapter was called to order at 7:30 p. m. in the Downtown Y. M. C. A. by Vice-Pres. J. F. Collins, Jr. Thirty-eight members and guests were present.

M. I. Dorfan of the Program Committee reported that sufficient material was available to continue the Symposium on Atmospheric Pollution at another meeting of the Chapter.

Secy. T. F. Rockwell read a letter from C. T. Baker of the Atlanta Chapter thanking Pittsburgh Chapter for their congratulations.

Secretary Rockwell reread the November 1935 letter to Chapters from John Howatt, pointing out that the prevention of atmospheric pollution was one of the problems of interest to the Society, and Chairman Collins then turned the meeting over to Mr. Dorfan.

Mr. Dorfan first discussed the scope of the subject of Atmospheric Pollution before presenting the speakers, who were: Director H. B. Meller, Air Hygiene Foundation, who spoke on the Sources of Atmospheric Pollution; Dr. Frank Holden, hygienist, Pittsburgh Plate Glass Co., who described the various instruments used in dust determinations; and H. R. Loxterman, engineer, Blaw Knox Co., who presented slides and described the various methods of dust collection which included the settling chamber, several types of cyclone separators, the viscous filter, the dry cloth filter and the electrical precipitator.

At the conclusion of the three formal papers, a general discussion followed in which many of the members participated.

The meeting adjourned at 10:45 p. m.

Pres. Boyden Guest of St. Louis Chapter

April 12, 1937. Pres. C. R. Davis called the meeting of St. Louis Chapter to order at Garavelli's restaurant at 7:25 p. m., when 15 members and 32 guests were present. Among the guests was D. S. Boyden, Boston, Mass., president of the A. S. H. V. E., who was welcomed with appropriate remarks by President Davis.

Minutes of the previous meeting were read and approved and Secy. R. J. Tenkonohy advised that the Board of Governors had elected the following to membership in the Chapter: A. G. Matousek, E. H. Ronsick, R. C. Driemeyer, B. L. Evans, J. S. Rosebrough, and E. C. Kuntz. It was also reported that J. S. Malone had affiliated with St. Louis Chapter.

D. J. Fagin reported for the Program Committee and stated that an interesting program was planned for the annual meeting.

L. R. Szombathy, of the Entertainment Committee, presented plans for the June party, and after discussion President Davis requested the committee to give the matter further study and report at the next meeting.

The report of the Nominating Committee presented the following slate of Chapter officers for the term of 1937-1938:

President—G. W. F. Myers.
First Vice-President—E. E. Carlson.
Second Vice-President—R. J. Tenkonohy.
Secretary—D. J. Fagin.
Treasurer—C. E. Hartwein.
Board of Governors—C. R. Davis, G. B. Rodenheiser, L. R. Szombathy and F. B. Fillo.

After a short recess President Davis introduced President Boyden, who spoke concerning Society affairs and then presented a paper on the Economic Uses of Purchased Steam. With the assistance of slides, he explained and illustrated the methods used in the recovery of condensate and its use in domestic water systems. Various apartments and hotel buildings in Boston were taken as examples to show comparative cost data. It was also brought out that condensate recovery is practical and the water is as sanitary as city water.

President Boyden completed his address at 8:25 p. m. and was kept on the floor for twenty additional minutes answering questions asked by the audience.

President Davis thanked Colonel Boyden for his visit to the St. Louis Chapter and those present extended to him a rising vote of thanks before adjourning the meeting.

Western New York Chapter Has E. H. Gurney As Speaker and Elects Officers

May 17, 1937. The annual meeting of Western New York Chapter was held at the University Club with approximately 35 members and guests in attendance. W. S. Eisele was welcomed into the Chapter as a new member.

Pres. P. S. Hedley expressed his appreciation to the retiring officers and committee chairmen for their cooperation during the past year. At the same time he spoke with regret of the four members lost to the Chapter by death: Messrs. Fraser, Coe, Danforth and Quigley.

C. W. Farrar and Joseph Davis told of the beauties of Swampscott and urged a large attendance at the summer meeting of the Society.

The following officers were elected for the year 1937-38:

President—B. C. Candee.
First Vice-President—J. J. Landers.
Second Vice-President—L. P. Saunders.
Secretary—W. R. Heath.
Treasurer—C. A. Gifford.
Board of Governors—D. J. Mahoney, M. C. Beman, Roswell Farnham, P. S. Hedley, Joseph Davis.

Mr. Beman, representing the Board of Governors, announced that certificates had been prepared for the Chapter's past presidents and on behalf of the chapter made the presentation to the following who were in attendance: L. A. Harding, C. W. Farrar, Roswell Farnham, M. S. Jackson, Joseph Davis, M. C. Beman, D. J. Mahoney, J. J. Yager and P. S. Hedley.

President Hedley turned the meeting over to President-elect Candee, who introduced the speaker of the evening, E. H. Gurney, Toronto, Ont., first vice-president of the A. S. H. V. E. Mr. Gurney related in an interesting manner his experiences during a three months trip to South Africa. He explained the working conditions of gold mines and the climatic conditions of that part of the world, bringing out the great value of air conditioning both commercially and for comfort, and told of the splendid opportunities available there for young engineers. Mr. Gurney mentioned the familiarity which the resident engi-

neers showed with the A. S. H. V. E. and how THE GUIDE was extensively used.

As a representative of the Officers and Council, Mr. Gurney traced briefly the history of the Society and mentioned the importance of the quality of the new members brought into it. He suggested that local associations be fostered with the senior medical societies, since he felt that air conditioning engineers and doctors needed each others' help.

Considerable interest was shown in Mr. Gurney's talk according to the report of Secretary Heath, and after discussion and a rising vote of thanks to the speaker, the meeting adjourned at 9:50 p. m.

Wisconsin Chapter Enjoys Visit of Pres. Boyden

May 11, 1937. Wisconsin Chapter came out in full force to greet D. S. Boyden, Boston, Mass., president of the A. S. H. V. E., who was guest of honor at the May meeting. After dinner a short business meeting was held and J. S. Jung submitted the report of the Nominating Committee.

Pres. M. E. Erickson appointed F. G. Weimer, chairman, and E. J. Gerstenberger and M. R. Spence as members of a committee to make arrangements for the annual picnic.

Ernest Szekely reported the publication of an air conditioning code for use in the State of Wisconsin and the chapter voted to appropriate $25.00 toward deferring expenses incurred in publishing this code and each member of Wisconsin Chapter is to receive a copy.

Honorary life membership was conferred upon Prof. G. L. Larson, Madison, in a resolution read by Secy. R. G. Koch.

President Boyden gave an interesting talk about the A. S. H. V. E. in which he related some of its history and showed how the ideals set forth in the constitution have been lived up to through the years since the Society's founding in 1894.

He quoted figures on the apportionment of dues to the various functions of the Society such as administration, publication and research and told of some of the various projects now in progress, as well as contemplated studies of the Committee on Research. Later President Boyden gave a short talk on the Economics of Purchased Steam, in which he pointed out many interesting problems and occurrences in this field and showed layouts and designs of central station steam plants together with examples of distribution systems.

Wisconsin Chapter feels indebted to President Boyden for his visit which was greatly appreciated by our members, says the report of Secy. Koch.

New Officers Elected by Cincinnati Chapter

May 11, 1937. Cincinnati Chapter held its annual meeting at the Hartwell Country Club, with approximately 30 members attending. In the afternoon members and guests played golf, trying out their niblicks on the new spring greens, and at 6:30 p. m. a delicious steak dinner was served.

Following dinner, the meeting was called to order by Vice-Pres. I. B. Helburn in the absence of Pres. E. B. Royer, who was recovering from an operation.

K. A. Wright gave the report of the Nominating Committee for Chapter officers as follows:

President—I. B. Helburn.
Vice-President—O W. Motz.
Secretary-Treasurer—H. E. Sproull.
Board of Governors—C. E. Hust and the officers.

It was duly moved that the nominations be closed and the Secretary was instructed to cast the ballots for the nominees as presented in the report of the committee.

During the meeting there was considerable discussion relative to the participation in the Technical and Scientific Society's Council of Cincinnati. It was agreed that the Chapter should continue to cooperate with the Council as in the past, and a special committee was appointed to handle details of the association.

The meeting then adjourned to the tap room where light refreshments were provided and an enjoyable time was had by all.

Members of the Cincinnati Chapter meet every Wednesday noon for luncheon in the Rathskeller of the Gibson Hotel and recently had the unexpected pleasure of having Secy. A. V. Hutchinson of the A. S. H. V. E. present, according to the report of Secy. H. E. Sproull.

Illinois Chapter Is Host to D. S. Boyden and Elects Officers

May 10, 1937. The final meeting of the 1936-37 season was held by Illinois Chapter at the Hotel Sherman, Chicago, when 114 were present to greet and hear D. S. Boyden, Boston, Mass., president of the A. S. H. V. E., and to listen to the annual committee reports and to participate in the installation of the newly-elected Chapter officers.

Pres. J. J. Hayes deferred the regular business and Colonel Boyden was introduced by John Howatt, past president of the Society. Mr. Boyden first presented life membership certificates to F. W. Powers and F. C. Black and then, in speaking about the A. S. H. V. E., he told the members that the Society is enjoying the largest membership in its history and he stressed the advantages of belonging, mentioning its research, publication and chapter activities. He pointed out that no other engineering society can equal the contributions to research of the A. S. H. V. E., with its own research laboratory in which over half a million dollars have been spent since its formation in 1919, not including the time or money involved in the many cooperative agreements with universities.

President Boyden also presented a paper on The Economic Uses of Purchased Steam and described a district heating system, with pictures and charts showing the boilers, electric load, steam consumption and demand, the distribution system and operation records. In the system discussed, the condensate is used for domestic hot water in the buildings served, instead of being returned to the plant. By reclaiming condensate for this purpose, records show annual savings to users which run into considerable money and a water analysis showed that condensate was purer than city water supplied in conventional fashion.

Announcements regarding the Semi-Annual meeting of the A. S. H. V. E. at Swampscott, Mass., as well as an invitation from the *Western Trade Golf Association* for the Illinois Chapter to hold a joint meeting July 22 were read by Secy. C. E. Price.

Three new members were announced by Tom Brown, chairman of the Membership Committee: J. C. Hines, Jules Medow and W. A. Kuechenberg.

Annual reports of the various committees were read and Secretary Price presented the statement of the Board of Governors, covering the Chapter activities for the year.

The treasurer's report, read by J. R. Vernon, showed a net gain of $39.46 and cash on hand as of May 8 of $704.96. This report was verified by the Auditing Committee headed by C. W. DeLand and placed on file. Similar treatment was given the reports of the Meetings Committee read by L. S. Ries, the Finance Committee headed by J. R. Vernon, the Membership Committee read by Tom Brown, and the Legislative Committee given by John Howatt.

The report of the special committee appointed to study the water problem in connection with air conditioning in Chicago's central business district was read by O. W. Armspach, chairman. The recommendations of the committee were: (1) Where conditions at the building permit, the equipment should be designed for heat dissipation to the atmosphere in lieu of the

sewer; (2) Where equipment is connected to the city water and sewer systems, automatic devices should be provided to regulate the quantity of water used. The excess use of water, particularly under less than maximum load conditions, should be discouraged; (3) Air conditioning equipment for all buildings falling within the so-called loop area which are connected to the city water or sewer systems should be designed to use the minimum quantity of water consistent with good engineering practice.

The report followed with a discussion of cooling towers and evaporative condensers. It presented a table of comparative first costs, operating costs, floor space required and weight of city water, natural draft towers, forced draft towers and evaporative condensers. It also warned against corrosion of air conditioning equipment from the sulphur dioxide present in the loop atmosphere. This report was accepted and filed and, upon motion of J. J. Aeberly, a copy was sent to the city engineer.

The election of officers was then announced, the ballots resulting in the following slate for the 1937-38 season:

President—L. S. Ries.
Vice-President—S. I. Rottmayer.
Secretary—C. E. Price.
Treasurer—J. R. Vernon.
Board of Governors—M. W. Bishop, Tom Brown, E. M. Mittendorff.

Retiring President Hayes called Mr. Ries to the chair and, in turning over the office to him, presented him with an inscribed gavel for use in presiding over the meetings of his administration and for his permanent possession upon retirement.

President Ries introduced the other newly-elected officers and announced the following committees to serve for the coming year:

Legislative Committee—R. E. Hattis, *chairman*, John Howatt, J. H. Milliken.
Membership Committee—E. M. Mittendorff, *chairman*, C. M. Baumgardner, B. A. Broom, J. T. Machen, G. G. Turner.
Meetings and Publications Committee—Tom Brown, *chairman*, S. I. Rottmayer, H. P. Reid, V. L. Sherman, N. W. Swanson.
Finance Committee—J. R. Vernon, *chairman*, J. C. Matchett, E. W. Rietz, O. W. Armspach, M. W. Bishop.

Michigan Chapter Elects Officers at Golf Meeting and Has Vice-Pres. Gurney as Guest

May 21, 1937. The annual golf meeting and election of officers of Michigan Chapter was held at Meadowbrook Country Club, when approximately 40 played golf and 65 attended the evening meeting.

Pres. R. K. Milward called the meeting to order at 8:00 p. m. and asked for roll call. He then introduced the officers and chairmen of the various committees.

President Milward gave a short resumé of each of the meetings held during the year. He called attention to the Semi-Annual Meeting of the A. S. H. V. E. at Swampscott, Mass., June 24-26, and urged all who could to attend. He also reminded the Chapter that the *Engineering Society of Detroit* had recently been given $500,000 by the Rackham Foundation to be used in constructing headquarters for the Engineering Society.

President Milward then read the report of the Nominating Committee for chapter officers for 1937-38, as follows:

President—F. J. Feely
Vice-President—F. J. Linsenmeyer
Secretary—G. H. Tuttle
Treasurer—J. S. Kilner
Board of Governors (3 to be elected)—W. H. Old, A. E. Knibb, W. C. Randall, H. F. Hutzel, F. R. Bishop, J. R. Bergan, S. S. Sanford.

Ballots were distributed by the tellers, Messrs. G. W. Akers, L. L. McConachie, and H. K. King, and resulted in the election of the officers as reported by the Nominating Committee. Messrs. Sanford, Bishop and Old were elected to the Board of Governors.

The Golf Committee, consisting of Messrs. R. L. Deppman, H. E. Paetz, and Anderson were called upon to award the golf prizes and the following were rewarded for their skill exhibited on the course during the afternoon: low gross (tied)—Mr. Anderson, I. E. S. lamp; R. K. Milward, cocktail set; high gross—G. B. Helmrich, I. E. S. lamp. Kickers' handicap prizes were awarded to Messrs. Pine, G. D. Winans, A. E. Knapp, Fisher, Pfeifer, E. P. Bailey, Jr., Leach, Lance and E. F. Ford. Players outside the handicap receiving prizes were Messrs. H. E. Paetz, J. F. McIntire, Lemmer, H. F. Hutzel, W. C. Randall and L. L. McConachie.

President Milward then turned over the gavel to the newly elected president, F. J. Feely.

Mr. Feely presented Mr. Milward with an inscribed token of appreciation signed by the officers and Board of Governors of the Chapter.

President Feely then called on each of the new officers and members of the Board of Governors before the meeting was adjourned at 10:30 p. m.

April 22, 1937. E. H. Gurney, Toronto, Ont., first vice-president of the A.S.H.V.E., was guest speaker at the Michigan Chapter meeting which was held at the Belcrest Hotel, Detroit. Approximately 75 members and guests were present.

Mr. Gurney related some of his experiences on a recent business trip to South Africa and he described conditions of high air temperatures and humidities, which are present in gold mines, and told how this problem is being met satisfactorily by air conditioning. Mr. Gurney also discussed A.S.H.V.E. activities and spoke of the necessity for closer cooperation between the Society and the medical profession.

The second speaker of the evening was F. R. Bishop who discussed the new technical code for mechanical warm air heating. Mr. Bishop pointed out that it was no longer necessary to design duct work for warm air heating systems by guess and stated that by using the information presented in the code a balanced heating system should result.

According to the report of Secy. G. H. Tuttle the meeting adjourned at 10:00 p.m.

Montreal Chapter Officers Elected; Refrigeration Discussed by John Everetts, Jr.

May 17, 1937. Thirty-three members and guests of the Montreal Chapter met at the Windsor Hotel for a dinner and meeting which was called to order at 8:00 p.m. by Pres. G. L. Wiggs. Roll was taken and three tellers were appointed to count the ballots for election of officers.

Annual reports were given by the President, Secretary, Treasurer, and Attendance and Membership Committee Chairman.

At the suggestion of T. H. Worthington, a discussion was held in regard to holding monthly luncheon meetings during the summer. The proposed golf meet was brought to the attention of the meeting and it was decided to hold this outing in June, and the following were appointed as a Golf Committee: A. B. Darling, *chairman*, John Colford, A. F. Lamontagne and T. H. Worthington.

The Society's Semi-Annual Meeting at Swampscott, Mass., was discussed and L. H. Laffoley and G. L. Ballantyne were appointed as an Arrangements Committee for the Montreal Chapter members attending the Semi-Annual Meeting.

The matter of the presentation of a Canadian Flag to the A.S.H.V.E. for use at Annual and Semi-Annual Meetings was discussed and a motion was made and seconded by Leonard Martin that Montreal Chapter purchase a flag for presentation to the Society at the summer meeting, June 24-26.

The report of the tellers was the next order of business and announced the election of the officers as nominated at the April meeting and of the following Board of Governors: A. B. Darling, W. G. Dewar, Leo Garneau, W. U. Hughes, J. P. Linton.

President Wiggs continued in office and the matter of local chapter dues and the cost of guest tickets was discussed.

In mentioning possible speakers for the coming year, it was

suggested that at least two local speakers be obtained and that the selection be made by the Board of Governors.

Mr. Hughes and J. A. M. Robertson, Jr., were appointed as auditors for the chapter books and the meeting adjourned at 11:30 p.m., according to the report of Secy. C. W. Johnson.

April 19, 1937. The regular meeting of Montreal Chapter was held at the Windsor Hotel with 40 members and guests attending. Following dinner, the meeting was called to order by Pres. G. L. Wiggs. Roll was called and introductions were made, after which the minutes of the previous meeting were read and approved.

The speaker, John Everetts, Jr., New York, N. Y., was introduced by President Wiggs and gave an illustrated lecture on Refrigeration as Pertaining to Steam Jet and Water Vapor Machines.

After the lecture an open discussion was held, and the meeting was later given over to routine Chapter business. A vote of thanks was given to Mr. Everetts by F. R. Barnsley on behalf of the Chapter.

The next order of business was a report from the Nominating Committee. In the absence of the chairman, L. H. Laffoley read the following list of officers and Board of Governors, as proposed by the Nominating Committee:

President—G. L. Wiggs
Vice-President—F. J. Friedman
Secretary—C. W. Johnson
Treasurer—F. G. Phipps
Board of Governors—A. B. Darling, Leo Garneau, W. U. Hughes, W. G. Dewar, J. P. Linton, G. L. Ballantyne.

A letter was read from headquarters office regarding the forming of an A. S. H. V. E. Chapter in Atlanta, Ga., and a motion was made and carried that Montreal Chapter wire their congratulations.

A discussion was held regarding the May meeting and resulted in a decision to hold a general business session with a question forum and a general get-acquainted meeting. It was also planned to hold a golf meet in June.

An announcement of the Semi-Annual Meeting of the Society at Swampscott, Mass., June 24-26, was made and it was urgently requested that Montreal Chapter have a good attendance.

Manitoba Chapter Holds Joint Meeting With Minnesota Members and Is Host to D. S. Boyden

May 24, 1937. An enjoyable meeting of Manitoba Chapter was held at Minneapolis, when Minnesota Chapter was host and provided an interesting and pleasant time for their Canadian guests.

It was voted that the Nominating Committee's report be carried unanimously and the following officers and committees were elected for the year 1937-38:

President—D. F. Michie.
Vice-President—William Glass.
Secretary—C. H. Turland.
Treasurer—H. R. Eade.
Board of Governors—J. B. Steele, Frank Thompson, E. F. Munn.
Membership Committee—J. B. Steele, *chairman*, G. C. Davis, W. Watson.
Nominating Committee—R. L. Kent, *chairman*, Frank Thompson, W. Worton.
Technical Program Committee—J. B. Steele, *chairman*, G. C. Davis, R. L. Kent.
Research Committee—G. C. Davis, *chairman*.

The visit with Minnesota Chapter was declared to be a memorable occasion and Secy. C. H. Turland reports that it is hoped this will not be the last of such meetings.

May 5, 1937. Members of Manitoba Chapter and their guests welcomed Col. D. S. Boyden, president of the A. S. H. V. E., and Mrs. Boyden, Boston, Mass., at a dinner and meeting held at the Fort Garry Hotel, Winnipeg.

During a short business session the invitation received from Minnesota Chapter to meet with them was discussed and approximately 14 Manitoba Chapter members promised to make arrangements to attend.

At Minneapolis, May 24, 1937

Back Row: D. F. Michie, M. H. Bjerken, N. D. Adams, Frank Thompson, C. H. Turland, J. B. Steele, R. E. Backstrom. *Front Row:* Mrs. Backstrom, Mrs. Thompson, Mrs. Adams, Mrs. Turland, Mrs. Bjerken. D. F. Michie, president, Manitoba Chapter, and R. E. Backstrom, president, Minnesota Chapter.

The Nominating Committee's Report as follows was approved and recommended for election at the annual meeting of the Chapter in Minneapolis on May 24.

President—D. F. Michie.
Vice-President—William Glass.
Secretary—C. H. Turland.
Treasurer—H. R. Eade.
Board of Governors—J. B. Steele, Frank Thompson, E. Fitz Munn.
Membership Committee—J. B. Steele, *chairman*, G. C. Davis, W. Watson.
Nominating Committee—R. L. Kent, *chairman*, Frank Thompson, William Worton.
Technical Program Committee—J. B. Steele, *Chairman*, G. C. Davis, R. L. Kent.
Research Committee—G. C. Davis, *chairman*.

After the routine business the members adjourned with President Boyden to the University of Manitoba, where they had the pleasure of listening to an interesting address which he gave on The Economic Uses of Purchased Steam. This was also attended by approximately 30 guests and a vote of thanks was given by Secy. C. H. Turland on behalf of the Chapter to President Boyden for his interesting lecture.

Northern Ohio Chapter Elects New Officers

May 17, 1937. Approximately 30 members and guests were present for dinner and 75 attended the meeting of Northern Ohio Chapter. Prof. G. L. Tuve reported on the Annual Meeting of the Society at St. Louis, and Pres. L. T. Avery brought up the matter of a delegate attending the Society's Semi-Annual Meeting at Swampscott, Mass. Professor Tuve announced his intention of being present.

F. A. Kitchen presented several copies of the new Northern Ohio Chapter By-Laws and reported for the Legislative Committee that Senate Bill No. 83 had been tabled.

R. A. Wilson reported the applications of C. C. Wooton for the A.S.H.V.E. and of Messrs. Moriarty, Bennett, and Wooton as Chapter affiliates.

President Avery appointed Professor Tuve as the Chapter's Research Representative.

The following report of the Nominating Committee for Chapter Officers for the coming year was presented by F. A. Kitchen:

President—Philip Cohen.
Vice-President—H. E. Wetzell.
Secretary—C. A. McKeeman.
Treasurer—A. L. Vanderhoof.
Board of Governors—L. T. Avery, H. M. Nobis, F. A. Rodgers.

As there were no additional nominations from the floor, the

slate as presented by the Committee was unanimously elected.

Mr. Avery announced to the sorrow of those present that A. L. Vanderhoof had been injured in an automobile accident and was confined in a hospital at Ashland, Ohio.

The meeting was turned over to C. F. Eveleth of the Program Committee who introduced the guest speaker, J. H. Walker, Detroit. Mr. Walker gave an interesting account of his studies on solar radiation in connection with air conditioning design and presented many details of the design of the new glass block building being erected by the Detroit Edison Co., including the air distribution and lighting systems.

After a lively discussion, the meeting adjourned at 10:30 p.m.

Symbols Committee Meets

Heating, ventilating, refrigerating, and air conditioning symbols were discussed at a committee meeting of the *American Standards Association* held in New York City on June 4.

A complete survey of existing symbols now in use was assembled on large charts for detailed study. Suggested symbols were selected from this composite group which could be used with the greatest ease by draftsmen, and with the least complication when represented on drawings of the various trades. Symbols as recommended by the committee are to be sent to various individuals and associations for comment.

Members of the Committee are E. E. Ashley, *chairman*, A.S.H.V.E., L. L. Munier and S. Lewis Land, *Heating, Piping and Air Conditioning Contractors National Association;* J. L. Murphy, *National Association of Master Plumbers of the United States;* E. L. Penfrase, *American Society of Sanitary Engineering;* L. H. Roller, *American Society of Refrigerating Engineers* and E. R. Wolfert, *Air Conditioning Manufacturers Association.*

R. C. Goddard Again Heads Stoker Manufacturers' Association

R. C. Goddard was re-elected president of the *Stoker Manufacturers' Association* at the annual convention at Greenbrier Inn, White Sulphur Springs, W. Va., June 3-4. E. C. Sammons, vice-president of Iron Fireman Mfg. Co., was elected vice-president of the association, and J. W. Ostrand of Link-Belt Co., was named treasurer.

J. McClintock, manager of the stoker division, Illinois Iron & Bolt Co., was selected chairman of the advertising and public relations committee, and E. C. Sammons was named chairman of the legislative committee. B. O. Fink, president, Auburn Foundry, Inc., was made chairman of the commercial committee; B. M. Guthrie, Fairbanks, Morse & Co., was elected chairman of the engineering committee, and J. E. Martin of Link-Belt Co. was made chairman of the membership committee.

Among those who participated in the general session June 4 were Geo. G. Ritchie, Chesapeake & Ohio lines; J. E. Tobey of Appalachian coals; W. B. Hughes of American Radiator Co.; Ralph A. Sherman, Battelle Memorial Institute; Fred K. Prosser of Norfolk & Western Railway; E. K. Scoggin of Minneapolis-Honeywell Regulator Co.; J. D. Battle of the National Coal Association, and Allen J. Johnson of Anthracite Industries Laboratory.

H.P. & A.C.C.N.A. Meeting

With a registration of more than 200 the 48th annual convention of the *Heating, Piping and Air Conditioning Contractor's National Association* was held at the Hotel Nicollet, Minneapolis, Minn., May 17-19, when action was taken to transfer the headquarters from New York City to Chicago, and officers were elected.

H. M. Porter, Minneapolis, was chosen president of the association for the ensuing year: G. H. Dickerson, Chicago, was re-elected vice-president; and F. E. Kise, Cincinnati, was named treasurer. J. L. DeNeille, St. Louis, and M. J. Chagnard, Louisville, in addition to the officers, were re-elected to the Board of Directors, and the two new directors chosen were H. E. Crook, Baltimore, and W. J. Olvany, New York.

The meeting adopted resolutions declaring the association's belief in the superiority of the apprentice system over the helper system and urging the establishment of an adequate training system; authorizing the officers to protest against PWA Administration Order 197; authorizing the continued membership of the association in the Chamber of Commerce of the United States, and in the Construction League, and instructing the officers to make a national study of the effects of the Robinson-Patman Act on the industry and to report their findings.

J. H. Zink, Baltimore, made the opening address and among the speakers were Walter Klie, Cleveland, chairman, Committee on Trade Promotion; G. H. Dickerson, Chicago, who reported on the Plumbing and Heating Industries Bureau; J. L. DeNeille, St. Louis, on 1937 Sales Problems of the Industry from the Contractor's Viewpoint; T. F. Hanley, Jr., Chicago, Committee on Certification; J. C. Fitts, New York, secretary of the association; S. L. Land, New York, educational director; John Coefield, Washington, president of the *United Association of Journeyman Plumbers and Steamfitters;* Charles A. Prosser, Dunwoody Institute, Minneapolis, on The Disappearance of Trade and Industrial Skill and Knowledge; J. P. Baldwin, Chicago, on Voluntary Codes; H. M. Hart, Chicago, chairman, Committee on Boiler Output; M. J. Chagnard, Louisville, chairman, Membership Committee; G. P. Nachman, Cleveland, chairman, Committee on Standards; H. E. Crook, chairman, Committee on Legislation; B. V. Moore, Minneapolis; E. G. Lanning, Camden, president, *Steam Heating Specialty Manufacturers' Association;* and G. J. Johnstone, president of the Minneapolis association.

Short Course in Coal Utilization

The University of Illinois held its fourth Short Course in Coal Utilization at Urbana, Ill., May 25-27, in conjunction with the annual convention of the *Illinois Fuel Merchants' Association.*

The session was opened by D. R. Mitchell, Department of Mining and Metallurgy, who introduced W. M. Christy, vice-president, *Illinois Fuel Merchants' Association,* as chairman. Dean M. L. Enger, College of Engineering, made the opening address and Prof. P. E. Mohn discussed domestic heating plants.

Other speakers at the sessions were C. M. Lewis, Kansas City, on common heating complaints; D. R. Michell on the problem of dust and smoke pollution; J. E. Martin, Chicago, on stoker sales; J. McClintock, who told of some of the early problems in connection with the installation and service of small stokers; W. B. Hughes, New York, who discussed air conditioning equipment for year 'round use; E. K. Scoggin, Minneapolis, on controls for stokers and household heating equipment; A. J. Chouinard, on market opportunities; H. N. Baum, Chicago, who spoke on advertising by the retail coal merchant and stoker dealer; Prof. J. R. Fellows on operating a household heating plant; K. C. Richmond, who presented data on stoker coal; J. W. Wallace, Detroit, on stokers and the advantages of year 'round hot water supply; and A. F. H. Scott, New York, who pointed out the heating equipment problem.

44th Annual Meeting and 5th Exposition

The Council of the Society has just announced that the 44th Annual Meeting will be held in New York City at the Biltmore Hotel during the fourth week of January 1938.

A well-balanced presentation representing every important phase of the industry is assured for the Fifth International Heating and Ventilating Exposition which will be held at Grand Central Palace, January 24 to 28. Judging by the calibre of exhibitors and their number, the event should be the most successful in the series of these expositions which have been held in

alternate years and in leading cities. For this year's showing three floors of Grand Central Palace have been reserved and at this time, seven months in advance of the opening date, all available exhibit space on the first two floors has been sold. Contracts covering one-third of the third floor space have been made with exhibitors.

An incentive to participate has been furnished by the new building activity which is everywhere under way.

Hotel air conditioning installations are significant in the onward march of the heating, ventilating and air conditioning industry. Rapid advance in the air conditioning of public buildings and commercial establishments has its parallel in offices and homes. Engineering improvements and demonstrated operating economies in room-unit air conditioners have a bearing on this trend.

Combustion in all its phases will be presented comprehensively at the Exposition. Combustion will be considered from the standpoint of the fuels utilized including oil, gas, and coal, and the equipment and accessories necessary to carry on the combustion efficiently. These include furnaces, burners, grates, stokers, refractories, boilers, and gages. The related field of steam and hydraulic equipment will be represented by traps, driers, feeders, heaters, pumps, valves, piping, hangers, fittings, thermal insulation, and expansion joints.

Central heating will be represented by exhibits of apparatus and materials designed to provide economical heating and humidification for building areas of every type. Refrigerating equipment in relation to air conditioning will include compressors, condensers, cooling coils, circulating pumps, and refrigerants.

One of the most interesting sections of the Fifth International Heating and Ventilating Exposition will be devoted to the engineering equipment used in the handling of air. Any project involving the cooling, heating, or transfer of volumes of air requires an assortment of ingenious devices all of which will be on display. Included are fans, blowers, humidification systems, ducts, filters, cooling towers, registers and grilles. Related to this field are such important items as unit heaters, ventilators, and motors.

Instruments of precision constitute a topic of incalculable importance to practically every modern industry. Quite naturally the heating, ventilating and air conditioning industries must rely upon such instruments to chart the characteristics of each installation and to carry it through. Instruments on display will include those for indicating, controlling, and recording temperature, pressure, volume, time, flow, draft, or any other function to be measured. The Exposition will also call attention to innumerable specialties for which space here does not permit full description. Electrical equipment will include machinery in wide variety such as motors and electrically driven pumps and fans, also electrical heating devices. The most modern metals and alloys will also be shown at the Exposition. Several exhibits will be devoted to the problems of plant management, and maintenance.

An Exposition Advisory Committee has recently been announced with the following personnel: D. S. Boyden, *Chairman;* E. H. Gurney, *Vice-Chairman;* E. E. Ashley, Potter Bowles, W. H. Carrier, W. A. Danielson, W. L. Fleisher, A. R. Herske, A. J. Johnson, G. L. Larson, A. J. Offner, C. R. Place, D. J. Purinton, L. L. Jacobs, *Oil Burner Institute;* H. T. Richardson, *National Warm Air Heating and Air Conditioning Association;* E. W. Smith, *Institute of Boiler and Radiator Manufacturers;* H. P. Morehouse, *American Gas Association;* Homer Addams, *Steel Heating Boiler Institute;* G. H. Dickerson, *Heating, Piping and Air Conditioning Contractors National Association;* H. M. Williams, *American Society of Refrigerating Engineers;* J. L. Harpham, *National Association of Air Filter Manufacturers;* E. J. Ritchie, *Steam Heating Equipment Manufacturers Association;* and R. W. Blanchard, *Register and Grille Manufacturers Association.*

The Exposition will be under the personal direction of Charles F. Roth, manager, who was similarly responsible for the earlier expositions in Chicago, New York, Cleveland and Philadelphia.

Chicago Exposition of Power and Mechanical Engineering

Announcement has been made of the Chicago Exposition of Power and Mechanical Engineering to be held at the New International Amphitheatre, Chicago, Ill., October 4-9, 1937.

William H. Wilson, Milwaukee, Dies

Society members in Milwaukee and others in the Wisconsin Chapter were saddened by the sudden death of William H. Wilson of a heart attack at his home, 2023 E. Olive St., Milwaukee, Wis., on May 30, 1937.

Mr. Wilson became a member of the American Society of Heating and Ventilating Engineers in 1923 and he was vice-president of the Wisconsin Chapter. At the time of his death he was Wisconsin and upper Michigan manager of the Johnson Service Co. Many members who attended the Semi-Annual Meeting of the Society at Milwaukee in 1932 will recall him as one of the hosts.

W. H. Wilson

Born on January 13, 1891, at Van Wert, Ohio, he came to Milwaukee a few years after graduating from high school there. He specialized in heat regulation and was associated with the Johnson Service Co. from October 1913.

Mr. Wilson was a member of Kenwood Lodge No. 303, F. and A. M., Kenwood Chapter No. 90, R.A.M., Galilee commandery, and Tripoli shrine. He was also a member of the Milwaukee Athletic and the Kiwanis Clubs.

Surviving are his wife, Mrs. Jeanette Hyde Wilson; a son, William H., Jr.; a sister, Miss Anna Cecile Wilson of San Diego, Calif.; and a brother, James C. of Winnetka, Ill.

The Society Officers and Council feel the loss of an active member and extend their sympathy to the members of the family who survive.

Death of James F. Firestone

The death of James F. Firestone, Dowagiac, Mich., occurred on May 8, 1937. Mr. Firestone had been a member of the A.S. H. V. E. for almost a quarter century, as he first joined the Society as a Junior Member in 1914.

Mr. Firestone was born at Lima, Ohio, on January 8, 1887 and he attended the Kansas State Normal School and the University of Michigan, receiving the degree of B.M.E. in June 1914. Following graduation Mr. Firestone was engineer for the Estate of P. D. Beckwith, Dowagiac, engaged in the manufacture of stoves and warm air furnaces. In 1930 he became associated with Montgomery Ward & Co., Chicago. Later and at the time of his death he was executive vice-president of the Round Oak Furnace Co., Dowagiac.

The Officers and Council of the Society regret the loss of a member of such long standing and they have expressed their sympathy to Mrs. Firestone, who survives.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 78 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by July 15, 1937, these candidates will be ballotted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ALBRECHT, H. P., Engr., Reinhard Bros., Minneapolis, Minn.	R. W. Kurtz N. B. Herman	H. M. Betts H. E. Gerrish
AMES, C. S., Design Engr., The Scott Co., Oakland, Calif.	G. J. Cummings A. J. Bouey	R. A. Hudson D. S. Boyden
AUSTIN, W. H., Engr., York Ice Mach. Corp., Boston, Mass.	James Holt H. C. Moore	C. L. Svenson (*A. S. M. E.*) W. H. Jones (*A. S. R. E.*)
BARNES, L. L., Air Cond. Engr., Clare & Co., Atlanta, Ga.	F. W. Clare T. T. Tucker	C. L. Templin E. R. Foss
BASTEDO, G. R., Lab. Asst., Standard Air Cond., Inc., New Rochelle, N. Y.	E. J. Denari (*A. S. M. E.*) W. A. Helmuth (*I. A. S.*)	R. C. Winslow (*A. I. E. E.*) J. G. Tholke, III (*A. I. E. E.*)
BENTLEY, C. E., Consulting Engr., G. M. Simonson, Berkeley, Calif.	B. M. Woods R. A. Hudson	W. E. Leland G. J. Cummings
BOXALL, FREDERICK, Engr., Delco-Frigidaire Cond. Div., Dayton, Ohio.	A. R. MacMillan Albert Buenger	W. A. Chapman, Jr. C. E. Lewis
BOWLES, E. N., Air Cond. Supervisor, Westinghouse Elec. & Mfg. Co., Chicago, Ill.	O. W. Armspach W. F. Christman	A. H. Goelz P. J. Marschall
BOYD, T. D., Sales Engr., Johnson Service Co., Cincinnati, Ohio.	K. A. Wright J. R. Vernon	G. B. Houliston J. A. Cutler
CABOT, M. A., Design Engr., University of Kentucky, Lexington, Ky.	Perry West J. W. May	R. C. Porter (*A. S. M. E.*) W. E. Freeman (*A. I. E. E.*)
CHERRY, V. H., Instructor, University of California, Berkeley, Calif.	B. M. Woods G. J. Cummings	J. I. Krueger L. H. Cochran
COCKINS, W. W., Sales Engr., The Trane Co., San Francisco, Calif.	B. M. Woods G. J. Cummings	A. J. Bouey J. I. Krueger
COGHLAN, S. F., Mech. Engr., Metropolitan Water Dist. So. Calif., Los Angeles, Calif.	E. H. Kendall H. B. Lauer	A. J. Hess Harrold English
COOPER, W. B., Sales Engr., Lamneck Prod., Inc., Columbus, Ohio.	D. B. Poling D. H. Wyatt	P. M. Kimmell A. W. Williams
DASING, EMIL, Vtg. Engr., Sears Roebuck & Co., Chicago, Ill.	E. M. Mittendorff J. E. McClellan	M. W. Bishop John Aeberly
DIAMOND, D. D., Design Engr., Twin City Furnace Co., Minneapolis, Minn.	H. M. Betts J. C. Davidson	R. W. Kurtz J. E. Swenson
DWYER, AUSTIN, Sales Engr., Delco-Frigidaire Air Cond. Div., East Orange, N. J.	Herbert Herkimer John Everetts, Jr.	J. L. Blackshaw J. Cowell (*Non-Member*)
EHLERS, JACOBUS, Resident Engr., Carrier Engrg. South Africa, Ltd., Johannesburg, South Africa.	E. G. Carrier Sydney Thompson (*A. I. E. E.*)	D. C. Lindsay (*C.M.M.S.S.A.*) S. Caldwell (*A. I. E. E.*)
FABLING, Owner, W. D. Fabling Co., Los Angeles, Calif.	E. H. Kendall H. B. Lauer	W. E. Barnum, Jr. H. M. Hendrickson
FENKER, C. M., Design Mech. Engr., Edward J. Schulte, Archt., Cincinnati, Ohio.	G. B. Houliston K. A. Wright	W. C. Green W. C. Pistler
FINNEY, BRANDON, Inspector, Htg. & Vtg. Div., City of Los Angeles, Calif.	Harrold English E. H. Kendall	J. Wanger (*Non-Member*) J. A. Martin (*Non-Member*)
FREDERICK, H. W., Asst. Supt., Engrg. Div., Lehman Hall, Harvard Univ., Cambridge, Mass.	James Holt D. S. Boyden	R. M. Nee G. D. Winans
GHILARDI, FERNAND, Chief Engr., Herdt et Charton, Inc., Paris, France.	Thomas McDonald J. H. Fox	André Nessi Auguste Beaurienne
GRAFF, W. F., Sales Engr., Standard Sanitary Mfg. Co., Grand Rapids, Mich.	W. W. Bradfield O. D. Marshall	H. D. Bratt P. O. Wierenga
GROOT, H. W., Chief Engr., The Home Comfortable, Inc., Louisville, Ky.	H. W. Moore W. M. Wallace, II	John Hellstrom B. M. Brigham (*A.S.M.E.*)
HANSLER, J. E., Zone Service Mgr., Delco-Frigidaire Cond. Div., Dayton, Ohio.	Albert Buenger C. E. Lewis	A. R. MacMillan B. K. Eaton

CANDIDATES

HARDY, F. L., Sales Engr., York Ice Mach. Corp., Birmingham, Ala.

HARRISON, G. G., Chief Engr., S. T. Johnson Co., Oakland, Calif.

HONERKAMP, FRITZ, Chief Engr., Anemostat Corp. of America, New York, N. Y.

HOUSKA, A. D., Clowe & Cowan, Inc., Amarillo, Texas.

HUTCHINSON, F. W., Mech. Engr., Calif. & Hawaiian Sugar Ref. Corp., Ltd., Berkeley, Calif.

HYDE, E. F., Consulting Engr., Birmingham, Mich.

KAUFMAN, H. J., Htg. & Vtg., Engr., Commonwealth & Southern Corp., Detroit, Mich.

KERN, J. F., JR., Asst. Editor, Heating & Ventilating, New York, N. Y.

KILLIAN, T. J., Htg. Contractor, Thos. J. Killian, Waukegan, Ill.

KINDORF, H. L., Chief Engr., Edward B. Ward & Co., San Francisco, Calif.

KOTHE, F. H., Resident Engr., Carrier Engrg. South Africa, Ltd., Durban, South Africa.

LAFFOLEY, L. H., Asst. Engr., Canadian Pacific Rly., Montreal, Que., Can. (*Advancement*)

LANE, J. C., Sales Engr., York Ice Mach. Corp., Kansas City, Mo.

LEHMANN, MATT, Engr., Ralph E. Phillips, West Los Angeles, Calif.

LEONARD, L. C. G., Draftsman, Messrs. McCann, Ltd., Dublin, Ireland.

MARSHALL, T. A., Sales Engr., York Ice Mach. Corp., San Francisco, Calif.

METZGER, H. J., Plbg. & Htg. Supt., Wheeler-Blaney Co., Kalamazoo, Mich.

MONTGOMERY, J. R., Mgr. Standards & Research, Truscon Steel Co., Youngstown, Ohio.

MOORE, W. R., Br. Mgr., Minneapolis-Honeywell Reg. Co., Atlanta, Ga.

MUIRHEID, J. G., Sales Engr., Page Williamson, Inc., Charlotte, N. C.

MURPHY, W. A., Gen. Sales Mgr., Watts Regulator Co., New York, N. Y. (*Reinstatement*)

OSBERGER, T. L., Mgr., Standard Sanitary Mfg. Co., Grand Rapids, Mich.

OWEN, J. D., Culver City, Calif.

PARK, J. F., Sales Engr., Western Air & Refrigeration, Inc., Los Angeles, Calif. (*Advancement*)

PETERSON, N. H., Mfrs. Agent, Neil H. Peterson Co., San Francisco, Calif.

PICOT, J. W., Director & Mgr., Unit Air Conditioners Pty., Ltd., Sydney, Australia.

POLLOCK, C. A., Mgr., Dominion Electro-home Industries, Inc., Kitchener, Ont., Can.

PRATT, F. J., Marine Engr., U. S. Navy Yard, Puget Sound, Bremerton, Wash.

PRYKE, J. K. M., Htg. & Vtg. Engr., London, England.

QUALL, C. O., Owner, Quall Plumbing & Htg. Co., Clintonville, Wis.

RABER, B. F., Prof. Mech. Engrg., University of Calif., Berkeley, Calif.

RINGIUS, John, Pres., United Blower Co., Inc., San Francisco, Calif.

ROCK, G. A., Partner, Forbes & Co., Miami, Fla.

ROSS, RODERICK, Consulting Engr., Melbourne, Australia.

SEELBACH, HERMAN, JR., Sales, Minneapolis-Honeywell Reg. Co., Buffalo, N. Y.

SEYMOUR, J. E., Partner & Mgr., Lee & Seymour, Madison, Wis.

SHEFFIELD, R. A., Owner, Air Cond. Engrg. Co., Cambridge, Mass.

SIEGEL, W. A., Supervising Engr., York Ice Mach. Corp., St. Louis, Mo.

REFERENCES

Proposers	*Seconders*
H. V. Fried R. L. Murphree	W. J. McKinney C. P. Lichty
W. E. Leland A. J. Bouey	R. A. Hudson G. J. Cummings
F. J. Kurth A. F. Hinrichsen	O. O. Oaks T. H. Urdahl
R. H. Anderegg M. W. Miller	S. B. Kitch (*Non-Member*) W. F. Freeman (*Non-Member*)
G. J. Cummings B. M. Woods	J. I. Krueger L. H. Cochran
W. H. Old W. G. Boales	G. D. Winans S. S. Sanford
W. G. Boales W. H. Old	S. S. Sanford G. D. Winans
C. H. B. Hotchkiss Clifford Strock	Bernard Leventhal John James
George Washington C. M. Baumgardner	S. R. Lewis R. H. Thomas
A. J. Bouey L. A. Mears	B. M. Woods G. J. Cummings
E. G. Carrier D. C. Lindsay (*C. M. M. S. S. A.*)	F. S. Stidfole (*A. I. E. E.*) Sydney Thompson (*A. I. E. E.*)
G. L. Wiggs W. U. Hughes	C. W. Johnson G. H. Osborne
L. J. Du Bois R. R. Irwin	A. G. Matousek G. W. F. Myers
R. M. Storms R. E. Phillips	L. H. Polderman O. W. Ott
D. Barrett (*I. H. V. E.*) H. A. Stirzaker (*I. M. E.*)	J. W. Cooling (*I. H. V. E.*) J. H. Duckworth (*I. H. V. E.*)
G. J. Cummings A. J. Bouey	J. I. Krueger B. M. Woods
O. D. Marshall W. W. Bradfield	P. O. Wierenga C. H. Morton
W. C. Randall G. D. Winans	G. J. Meyer (*Non-Member*) A. H. Schaffert (*Non-Member*)
H. K. McCain W. J. McKinney	R. F. Hahn L. B. Miller
A. R. MacMillan Albert Buenger	H. W. Moore J. S. Beechler
J. K. Peacock N. P. Fenner	M. C. Gillett C. V. Haynes
W. W. Bradfield C. H. Morton	O. D. Marshall P. O. Wierenga
E. H. Kendall Harrold English	H. B. Lauer Arthur Hess
E. H. Kendall H. B. Lauer	Harrold English A. J. Hess
B. M. Woods G. J. Cummings	A. J. Bouey J. I. Krueger
J. A. Robinson J. H. Banks (*Non-Member*)	Arthur Pilz (*A. M. I. E.*) F. Maw (*A. M. I. E.*)
C. Tasker E. A. Allcut	Arthur Wilkinson G. R. Beavers
S. D. Peterson W. W. Cox	R. E. Johnson (*A. S. M. E.*) L. L. Bysom (*P. S. N. Y.*)
C. M. Humphreys L. W. Moon	T. F. Rockwell P. A. Edwards
L. W. Hessler S. G. Swisher, Jr.	F. G. Weimer R. G. Koch
B. M. Woods G. J. Cummings	O. W. Ott E. H. Kendall
J. I. Krueger G. J. Cummings	B. M. Woods A. J. Bouey
A. E. Christen (*Non-Member*) Maurice Connel (*Non-Member*)	W. M. Fry (*Non-Member*) S. F. Gardner (*Non-Member*)
G. Chittleborough (*I. E. A.*) A. C. Leith (*I. E. A.*)	A. S. Ridley (*I. A. E. A.*) W. Fyvie (*I. M. E.*)
Roswell Farnham Joseph Davis	B. C. Candee P. S. Hedley
G. L. Larson D. W. Nelson	C. L. Dean I. F. Lounsbury (*A. S. R. E.*)
G. B. Gerrish James Holt	H. L. Farrow M. G. Knowles
E. E. Carlson L. J. Du Bois	H. W. Meinholtz G. W. F. Myers

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
STITES, RICHARD, JR., Engr., The Coon-De Visser Co., Detroit, Mich.	A. A. Criqui Roswell Farnham	W. R. Heath J. J. Yager
STROCK, CLIFFORD, Assoc. Editor, Industrial Press, New York, N. Y. (*Advancement*)	R. B. Purdy C. H. B. Hotchkiss	G. G. Turner M. C. Barnum
THORNTON, T. L., Maintenance Engr., Prudential Insurance Co., Newark, N. J.	P. J. Bryant L. B. Ray	John James J. H. Guest (*Non-Member*)
TUTTLE, G. H., Combustion & Htg. Engr., Detroit Edison Co., Detroit, Mich. (*Advancement*)	E. E. Dubry G. D. Winans	R. K. Milward J. H. Walker
ULLRICH, A. B., Jr., Gilbert Engrg. Co., Dallas, Texas.	H. W. Skinner R. F. Taylor	L. L. Landauer F. J. Kurth
WARD, E. B., Air Cond., Edw. B. Ward & Co., San Francisco, Calif.	B. M. Woods A. J. Bouey	J. I. Krueger L. H. Cochran
WARREN, J. S., JR., Air Cond. Engr., York Ice Mach. Corp., St. Louis, Mo.	L. J. Du Bois G. W. F. Myers	E. E. Carlson E. F. Edwards (*Non-Member*)
WATT, R. D., Design Engr., Electrol Oil Burner Corp., Seattle, Wash.	E. L. Weber E. O. Eastwood	James Holt A. C. Denny (*Non-Member*)
WAYLAND, C. E., Vice Pres., Western Asbestos Co., San Francisco, Calif.	R. A. Hudson G. J. Cummings	J. I. Krueger A. V. Hutchinson
WEBER, E. F., Jr., Sales Engr., York Ice Mach. Corp., St. Louis, Mo.	L. J. Du Bois R. R. Irwin	A. G. Matousek E. E. Carlson
WESTPHAL, N. E., Student, Purdue Univ., West Lafayette, Ind.	J. D. Hoffman A. A. Potter (*A.S.M.E.*)	W. T. Miller (*Non-Member*) G. A. Young (*Non-Member*)
WITMER, H. S., Design Engr., Dail Steel Prod. Co., Lansing, Mich.	B. F. McLouth E. B. Root	L. G. Miller H. B. Dirks (*A. S. M. E.*)
WOOD, C. F., Educational Dept., Frigidaire, Dayton, Ohio.	C. E. Lewis M. J. Stevenson	Albert Buenger A. V. Hutchinson
WOOTAN, C. C., Htg. Salesman, Crane Co., Cleveland, Ohio.	L. T. Avery Philip Cohen	J. A. Schurman R. A. Wilson

Candidates Elected

In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

BADGETT, W. H., Research Asst., A. & M. College of Texas, College Station, Texas. (*Advancement*)

BAENDER, F. G., Pres., Thermo Air Cond. Inst., Inc., Los Angeles, Calif.

BEAULIEN, A. A., Utilization Engr., Edison Elec. Ill. Co. of Boston, Boston, Mass.

BOYD, S. W., Consulting Engr., Newcomb & Boyd, Cons. Engrs., Atlanta, Ga. (*Reinstatement and Advancement*)

DOWLER, E. A., Sales Engr., B. F. Sturtevant Co. of Can., Ltd., Toronto, Ont., Can.

GANGE, F. B., Managing Director, Gordon & Co., Ltd., Shanghai, China.

GAUSE, H. C., Power Sales Engr., Alabama Power Co., Birmingham, Ala.

GUMAER, P. W., Consulting Engr., New York, N. Y.

JONES, A. T., Mech. Engr., S. A. Armstrong, Ltd., Toronto, Ont. Can. (*Advancement*)

RICHFIELD, N. H., Field Engr., Delco-Frigidaire Cond. Div., New York, N. Y.

SHEPHERD, C. B., Chemical Engr., E. I. du Pont de Nemours & Co., Wilmington, Del.

SMITH, W. D., Pres., Bryant Smith, Inc., Cleveland, Ohio. (*Advancement*)

TWIZELL, E. W., Partner, Connolly & Twizell Regr., Montreal, Que., Can.

WADE, R. H., Sales Engr., Spencer Heater Co., New York, N. Y.

WILKES, G. B., Prof. Heat Engrg., Mass. Inst. of Tech., Cambridge, Mass

ASSOCIATES

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CARLSON, C. O., Proprietor, C. O. Carlson Htg. Co., Minneapolis, Minn.

FISHER, G. B., Vice Pres., Midwest Air Cond. Corp., St. Louis, Mo.

HALLAR, E. V., Mgr., Coglizer Insulation Co., Kansas City, Mo.

HERSH, F. C., Engr., Penn. Power & Light Co., Allentown, Pa. (*Reinstatement and Advancement*)

KILLIAN, V. J., Htg. Contractor, V. J. Killian Co., Winnetka, Ill.

KNOWLES, E. L., Mgr., Marshall Htg. Co., Minneapolis, Minn.

LABOV, MILTON, Vice Pres., Benj. E. Labov & Son, Atlantic City, N. J. (*Reinstatement and Advancement*)

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LOWER, H. C., Sales Engrg. Contact, J. J. Gibbons, Ltd., Toronto, Ont., Can.

PELOUZE, H. L., 2nd, Br. Mgr., C. A. Dunham Co., Richmond, Va. (*Reinstatement and Advancement*)

PETERSEN, C. P., Proprietor, Petersen Sheet Metal Works, Minneapolis, Minn.

REINKE, L. F., Owner, Reinke Sheet Metal Works, Milwaukee, Wis.

JUNIORS

DONNELLY, M. A., Sales, McArdle & Cooney, Philadelphia, Pa.

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JOHNSTON, R. M., Instructor Dept. Mech. Engrg., Va. Polytechnic Inst., Blacksburg, Va.

PRITCHARD, W. J., Br. Mgr., Carrier Corp., Newark, N. J.

SALINGER, R. J., Engr., General Refrigeration Sales Co., Kansas City, Mo.

STEWART, J. P., Engr., Carrier Corp., Newark, N. J.

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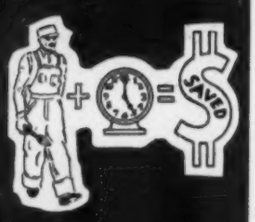

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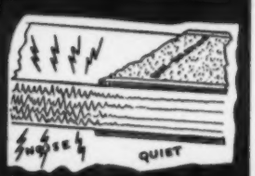

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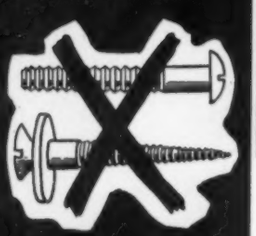

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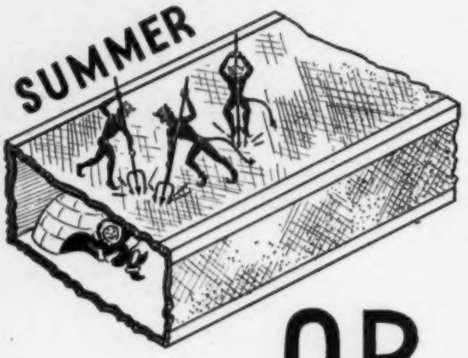

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Warm or Cold air is delivered at desired temperatures in air conditioning systems that are insulated with Dux-Sulation. With a conductivity of only (K) .27 B. T. U. which allows a minimum heat loss, a desired register temperature can be maintained. This efficiency means a big fuel saving.

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Booklets, Reports and Papers

Advantages of Air Conditioning Newspaper Plants Outlined

Defining a newspaper plant as "a factory for producing sheets of paper somewhat soiled by a deposit of carbon black in petroleum, in large quantities as fast and as cheaply as possible," Robert T. Williams, engineer, Carrier Corp., went on to discuss the air conditioning requirements of such plants before the 11th annual mechanical conference of the American Newspaper Publishers' Association at Chicago last month.

He mentioned one point that has received, he felt, far too little consideration, both from people who buy air conditioning and from those who design and sell it; that is, that the heating of a building is just as much a part of an air conditioning problem as is the cooling, and in fact, in most parts of this country, a rather more important part. We have been far too apt to think of air conditioning as something that cools the building in the summer time without taking into consideration the fact that air conditioning should do the heating in the winter, and that a system improperly or haphazardly designed for the heating season, can cause 100 per cent more grief and discomfort than any advantages which may be secured from its summer time cooling. A properly designed air conditioning system should heat the building evenly without drafts, without much temperature difference over the surface of the areas, and with economy.

Having discussed some of the fundamentals of air conditioning, he then outlined the special considerations for the conditioning of a newspaper plant. In the offices the primary considerations are human comfort and efficiency. If there are a large number of small private offices, the question of individual control for each office must be given consideration. In such general offices as city rooms, human comfort is again of primary consideration, together with draftless distribution; and special attention must be given to adequate outside air supply, due to smoking. Other areas which may require special treatment are telephoto rooms, near which it is inadvisable to place moving machinery, as vibration must be cut down to a minimum; and broadcasting studios, where absence of noise is a very important factor. In the public spaces in a newspaper building, the installation of the system must be made in such a way that it will not disfigure the architectural features.

Press Room an Important Application

The principal place where air conditioning affects process as well as personnel is the press room, he said. To the two commonplace requirements of ventilation and heating modern practice indicates the humidification of a press room, and the provision of some method of carrying away the heat generated by the press. Humidification of a press room results in better press work; in better, sharper looking paper; and snappier half-tones. With the increase in use of pictures, both in the news and advertising columns, this is a matter of great value to the publisher. Humidification keeps the paper in a softer condition, giving it a better printing quality, partly due to its absorption of moisture and partly, he believed, to the elimination of static electricity which keeps the fuzz on the surface of the paper lying flat rather than standing up straight. Furthermore, the elimination of static will result in fewer web breaks on the press, as a certain number of these are caused, he felt, by a certain brittleness of the edges of the paper in combination with a drag caused by static.

A surprising result of the humidification of a press room is a reduction in ink consumption of about 10 per cent.

Humidification of the press room tends appreciably to reduce the formation of ink mist. This unpleasant feature of most press rooms has never been satisfactorily explained. However, one

Never-failing Water Supply . . . Necessity for Successful Air Conditioning

The Minneapolis-Honeywell Regulator Co. has had long experience in air conditioning and its related problems. They know the importance of dependable pumps.

Accordingly, when *their* plant was air conditioned, they chose a Fairbanks-Morse integrally built turbine pump and motor unit. This served so well that a supplementary duplicate unit was added in 1935.

Experienced engineers consistently specify F-M pumps. They know that the tremendous variety of F-M pump experience means efficient, dependable pumps for the new field, air conditioning. And every F-M air conditioning pump has increased that confidence.

With F-M you get undivided responsibility behind both pump and motor, and many other advantages explained in Bulletin 6920-40. Write for it. Address Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill. 34 branches at your service throughout the United States.

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"NOTHING LIKE LEATHER"
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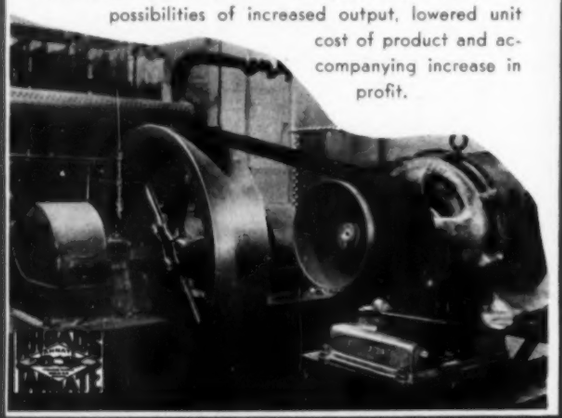
Since the industrial revolution began, following the common use of the steam engine, an enormous number of materials have been tried for the mechanical transmission of power by belting. Among the first used of these was leather, followed by many types of fabric belting. Under the rigorous test of time, modern scientific developments of belting have improved as loads and speeds of machines increased. But for the great majority of industrial drives, and especially the severe ones, there is still "nothing like leather."

Other types of belting nearly always show a lower first cost than does Rhoads Tannate Belting, but the wide extent of its use in many of the most progressive industries indicates that many managers have found that it usually gives increased output, lower cost for operation, and longer service life than other types; in a word, lower cost per unit of output.

Usually first quality belts have one or more outstanding good points that justify their classification as "first quality belts." Few, indeed, have the **COMBINATION** of **OUTSTANDING QUALITIES** required by the best engineering practice that are found in Rhoads Tannate Leather Belts.

These scientifically developed qualities combined in the Tannate give you dependable, long-life belt-service, with lower maintenance and replacement costs and possibilities of increased output, lowered unit cost of product and accompanying increase in profit.



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of the causes of it appears to be the generation of a small static charge of finely divided ink particles thrown off by centrifugal force from the rollers at high speed, and humidification, tending to dissipate this static charge, does actually cut down this difficulty. The formation of ink mist appears to increase somewhat according to the square of the velocity of the press; and as presses continue to increase in speed, this problem is going to become more acute. Up until the present time, we have treated this ink mist problem with some success by humidification and by dilution,—that is, supplying to the press room a large quantity of outside air and furnishing positive exhaust. Work is now being done in the direction of direct ventilation of presses at the source of the ink mist, in order to remove this; but this will again be combined with a humidifying system for supplying the air which will be exhausted.

In connection with the press room system, it is desirable to humidify the stock storage spaces, in order to prevent the ends of the rolls from becoming dried out and brittle, particularly when stored near steam coils or in heated areas. This is purely a winter time requirement, and may economically be done as a sort of byproduct of the press room system, using the excess of air not needed in the press room during winter.

Mr. Williams concluded by remarking on the importance of proper air distribution, the essence of satisfactory air conditioning. If the air is not distributed evenly without unpleasant drafts, and does not reach the place where the work is to be done, the system is unsatisfactory, he said.

Air Conditioning Opportunities, Problems of the Electric Utility

Earl W. Gray, in charge of air conditioning, commercial department, Oklahoma Gas and Electric Co., spoke on "Conditioned Air—Its Opportunities and Problems" at the annual convention of the Edison Electric Institute held at the Palmer House, Chicago, last month.

Every new business brings its opportunities for those who will accept them, said Mr. Gray, and air conditioning brought to the electric utilities an opportunity to build their load beyond anything dreamed of. What is equally important, it gave them an opportunity to assist their customers in profiting from this development.

Mr. Gray described how his company has promoted air conditioning, beginning in 1933, and stated that they now have on their lines 490 air conditioning and air washing installations totalling 6,600 hp. He stressed that in no sense are their promotion activities in competition with consulting engineers, and that on many jobs they recommend that an engineer be retained.

He mentioned that the utilities are not the only ones who have had problems. The manufacturers have had their share, and one of the most trying has been the difficulty of finding satisfactory outlets. In some instances distributors of household refrigerators undertook the distribution of air conditioning equipment with their regular dealers as sales outlets. They soon learned that this was a new type of business and that, although their entire organization and training had been centered on merchandising, they were now in the contracting business, a highly specialized one at that. They found that instead of specialty salesmen they had to have sales engineers as well as design and installation men who added heavily to their overhead.

Continuing his discussion, he stated that the room cooler offers a medium for volume sales of air conditioning. It is something that can be handled by the dealer in the small town and sold with a minimum of sales expense. The manufacturers have prepared survey forms with which in a few minutes the salesman can determine whether his room cooler is applicable or whether larger equipment is required. The dealer is doomed to failure who, instead of giving his salesmen some training in the fundamentals of air conditioning.

starts them out with the idea that his cooler is good for so many square feet of floor space and that outside air is a non-essential.

Room cooler installations present problems that must be given attention. The tendency has been to sell them as socket appliances, but we know that motors of the size necessary in the larger models will not generally operate satisfactorily on 115 volts because few of our older buildings have circuits larger than No. 14 wire. Some dealers think that the utility is unusually severe in requiring that motors above ½ hp be operated at 230 volts. After a few experiences with motor trouble and after we have convinced them that we are furnishing full voltage at the entrance, they decide that there may be a reason for such a requirement. Unfortunately, some manufacturers are shipping out machines built only for 115 volts, with no provision for reconnection. The horsepower rating is not an index of the power input as we find room coolers with ¾ hp motors having an input of 1,250 watts. Other air cooled room coolers have a total input for compressor and fans as high as 1,500 watts.

Heavy air conditioning load in congested areas served from an underground system, requires a large investment in facilities to serve low load factor business, he pointed out. The utilities and the manufacturers must work together to improve the characteristics of this load. Further developments in the use of the reversed cycle of refrigeration for winter air conditioning, and various types of storage systems offer promise. There is now being installed on the system a combined direct expansion and storage system which will handle a 130 ton load with a 75 hp compressor, he reported.

In concluding, he stated that it is impossible to vision a limit to the potential air conditioning load. The head of a large manufacturer of air conditioning equipment recently stated that air conditioning sales during 1936 amounted to $43,000,000 and he predicted sales of $350,000,000 annually by 1945. If sales of $43,000,000 represented an addition of 136,000 hp last year, then by the close of 1945 we can expect to add 5,000,000 hp. At a nominal figure of $20 per hp, the utility industry can then expect $100,000,000 additional annual revenue.

Briefly Noted

Heating Boilers—Simplified practice recommendation R157-37, steel horizontal firebox heating boilers. Lists 19 sizes ranging from 1800 to 35,000 sq ft steam radiation, hand firing; mechanically fired, 2190 to 42,500 sq ft. Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 5c.

Fans—Comparison chart for ventilating fans, incorporating minimum recommended standards of gauges of steel for fan housings. *National Association of Fan Manufacturers,* 5-208 General Motors Bldg., Detroit, Mich.

Protection of Welders—Health Protection of Welders, a 27 p. booklet issued by and available from the Policyholders Service Bureau, Metropolitan Life Insurance Co., New York, N. Y.

Gas Air Conditioning—June issue of *Air Conditioning Trends,* devoted to the application of gas air conditioning, with special consideration given to cooling and dehumidifying. Available upon request on business letterhead to Keeney Publishing Co., 6 N. Michigan Ave., Chicago, Ill.

Coal Specifications—General coal specifications for Michigan state institutions, by W. H. Mark Hanna, State Efficiency Engineer, issued by the State Administrative Board.

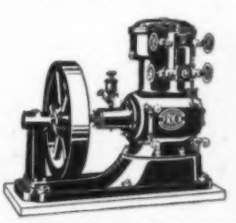
Thermal Conductivity—Thermal conductivity of building materials, by Frank B. Rowley and Axel B. Algren, a 134 p. bulletin published by the Engineering Experiment Station, University of Minnesota, Minneapolis. Price, $1.00.

Alignment Charts—Their Construction and Use, by Paul

Refrigeration

Is being used to air condition the Philcade and Philtower Buildings in Tulsa—the largest contract for work of this kind ever let in the southwest. Four Frick 12" by 12" ammonia compressors carry the cooling load, which totals 900 tons of refrigeration.

Whether for conditioning air, making ice, food service, cooling drinking water, quick freezing, cold storage, test and research, marine work or any other cooling job, there's a Frick System of the size and type to suit your needs exactly. Branches and Distributors in principal cities throughout the world.


Frick Enclosed Ammonia Compressor

WAYNESBORO, PENNA. U.S.A.
FRICK CO.
DEPENDABLE REFRIGERATION SINCE 1882

AS OTHERS SEE US

In a recent survey to determine the attitude of motor buyers toward the leading makes, some very enlightening facts were discovered.

In all cases where the Leland was among the makes considered, it was "in the money" on all the following counts:

Design and engineering service
Field service
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Dealer acceptance
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Design features with special sales appeals.

Investigate the Leland motor. It belongs on YOUR appliance.

THE LELAND ELECTRIC COMPANY
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N. Lehoczky, a 62 p. bulletin of the Engineering Experiment Station, Ohio State University, Columbus, Ohio. Price, 40c.

Chicago Ordinances—Mimeographed reprint of sections of revised Chicago code of 1931 relating to heating, including ordinances relating to departments of inspection of steam boilers, unfired pressure vessels, and cooling plants; smoke inspection and abatement; and others. Available from Municipal Reference Library, Room 1005, City Hall, Chicago, for 25c plus 5c when sent by mail. Also ordinances relating to ventilation and refrigeration, on sale at 25c and 10c respectively.

Air Conditioning—Why bother about air conditioning,, an article by Anson D. Marston, in the May, 1937, *Edison Electric Institute Bulletin,* including data on energy consumption for air conditioning. Published by the *Edison Electric Institute,* 420 Lexington Ave., New York, N. Y.

Odor Control Methods—Use of activated coconut carbon, a paper by F. H. Munkelt presented at the spring meeting of the *American Society of Refrigerating Engineers,* 37 W. 39th St., New York, N. Y., and published in the journal of the Society, *Refrigerating Engineering.*

District Heating—Reports presented at the annual meeting of the *National District Heating Association,* 1317 Spruce St., Philadelphia, Pa. Research committee report—Improving performance of steam jet coolers; distribution losses. Steam station engineering committee—Changing a district steam heating plant from hand-fired coal to automatic heavy oil; modern power plant piping; operating experiences. Commercial relations committee—Economical use of steam for heating. Distribution committee—Effect of design on cost of underground steam lines and manholes for a 12 in. steam line (a symposium). Chemistry committee—Steam purity; pretreatment of coal. Operating statistics committee—pertinent statistics. Meters and accessories committee—Shunt flow meter demand attachment; tentative specifications for steam metering; report on development of new flow meter. Hot water committee—Present status of heat unit meters.

Smoke Removal in Air Conditioning

Smoke removal in air conditioning was discussed by G. W. Penney, research engineer, Westinghouse Electric & Mfg. Co., at the meeting of the *Smoke Prevention Association* at New York City last month. He described in particular the cleaning of air by the electrostatic precipitation method.

Much of the smoke in our city air is in the form of very small particles, so small that settling is usually negligible, and most devices now in common use for cleaning air in air conditioning do not remove these fine smoke particles effectively, he said.

Electrostatic precipitation has long been recognized as an outstanding means of removing fine particles. A new type of precipitator has been developed which is applicable in air conditioning. Experimental installations, which have been running for several years, have given excellent results from the standpoint of keeping buildings clean, as an aid in the treatment of hay fever and asthma, and in certain difficult air cleaning applications in industry.

Electrostatic precipitation consists essentially of imparting a charge to each dust particle and then attracting the particle out of the air. In previous practice both functions were performed in a single chamber. The charging of the particle inherently requires a non-uniform field to give the corona discharge while the separation of the particles requires a uniformly high field. In order to raise the voltage gradient over the space to a sufficient value the voltage was raised until considerable current was passed which generated large amounts of ozone and nitrous oxides.

In the new system the ionization is produced in a separate chamber. The separation of the particles is then accomplished by passing the air between parallel plates where a uniformly high gradient can be maintained and where a dust particle must travel only a short distance perpendicular to the air flow before it is removed from the air stream.

These 3 floors

of the "Bon Marche," Canton, Ohio, are wholly Carbondale Air Conditioned . . .

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RANDALL D. R. O. R. PILLOW BLOCK

Randall for ECONOMICAL QUIET BEARINGS

The Randall D. R. O. R. (double reservoir oil return) precision bored pillow block is built to give you long, economical service, with complete freedom from bearing worries.

Excess oil flows into the lower wool packed reservoir from which it is returned as needed through graphite feed plugs to the shaft. Because of this exclusive feature ample lubrication is provided the shaft even though regular oiling be neglected.

Metallic bearing noise is eliminated in blowing systems equipped with Randall Bearings. And largely because of this feature, Randall Bearings are used by more than 75% of air conditioning manufacturers.

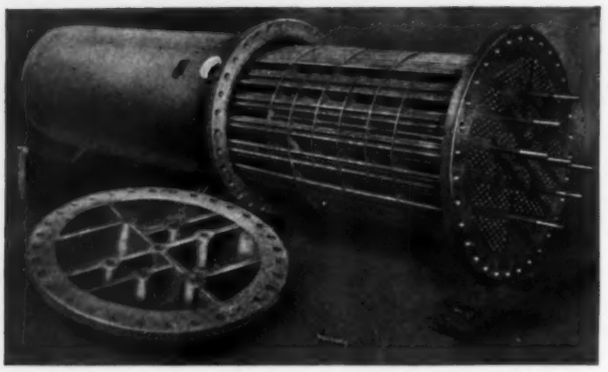
The D. R. O. R. Pillow Block is self-aligning, self-lubricating and operates with minimum running torque. It is rapidly becoming the most popular of all pillow blocks in the air conditioning field.

Above is a cut-away section of the ball of the D. R. O. R. and Flange Type Pillow Block showing Double Reservoir Oil Return feature.

The Randall Flange D. R. O. R. Pillow Block is for vertical mounting as on unit heaters and cabinet type air conditioning equipment. It holds three times as much oil as the Standard Pillow Block.

Randall GRAPHITE PRODUCTS CORP.
Dept. 710 609 W. Lake St., Chicago, Ill.

Patterson Freon Water Coolers



Designed to cool water in closed or open circuits with Freon or similar refrigerants by expanding the refrigerant within the tubes and circulating water around them. The tubular cooling surface is in multi-pass arrangement, insuring a long travel of the refrigerant.

The water is caused to flow back and forth across the tubes by a series of transverse baffles. This provides a turbulent flow throughout the entire travel and insures a high rate of heat transfer from water to refrigerant.

Patterson Coolers are built with welded steel shells, rolled steel tube sheets, semi-steel expansion chambers, and copper tubes and baffles.

The U-tube construction permits removal of the entire tube bundle for inspection and cleaning and provides for expansion and contraction of each individual tube independently of all others.

There is but one gasketed joint in contact with Freon. Gaskets are of fibre especially resistant to the action of Freon. All coolers are designed for a working pressure of 150 lbs. in both shell and tubes.

To provide permanent segregation of refrigerant charges for each compressor when more than one is used, these coolers are designed for as many circuits as there are compressors. This division of circuits is accomplished by dividing the expansion chamber with ribs to insure the desired passage of the refrigerating charge.

All coolers, after fabrication, are tested for tightness with Freon under pressure. After completed and tested they are drained and the refrigerant side is carefully dried or dehydrated by a special process to prevent moisture mixing with the refrigerant charge. After dehydration all openings are closed with screwed plugs to preserve the dry state.

Write for Booklet.

The Patterson-Kelley Co., Inc.

107 WARREN ST. EAST STROUDSBURG, PA.

Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 142. Add the new products and companies listed here to your Directory Section which you received in your January, 1937, HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

Self-Contained Cooling Unit Is Offered

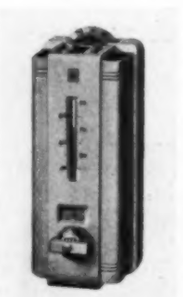
No. 1252—A newly designed self-contained cooling unit for residential and office cooling is manufactured in one size to provide a ¾ ton cooling capacity with a sensible heat rating of 6,400 Btu per hr and a total rating of 9,000 Btu. Air circulation is 360 cfm. This unit can be situated anywhere in the room, and does not have to be near or under a window.

The unit consists of a reciprocating "Freon" compressor, water cooled condenser, evaporator, fan and motor, all automatically controlled and housed in a compact, insulated cabinet. Air is drawn through an evaporator in the rear of the cabinet, where it is cooled and dehumidified. It is then directed to the occupied portion of the room by a propeller fan through a grille which delivers the conditioned air directly downward and across the floor. This produces a maximum cooling effect per unit of electrical energy used, the maker says. Two control knobs are located on the side of the cabinet. With one knob the fan can be turned on separately or with the compressor. The other knob provides adjustment of the automatic thermostat for the degree of cooling desired.

The cabinet is 31⅝ in. high, 30⅝ in. wide and 15⅜ in. deep.—Herman Nelson Corp., 1824 Third Ave., Moline, Ill.

New Day-Night Thermostat Announced

No. 1253—New "Da-Nite Acratherm" combines the "Acratherm" and the "Time-O-Stat" into one small, attractive thermostat offering in one instrument, manually lowered temperature, night or day, with resultant fuel economy and automatic return to the desired temperature level whenever wanted, and the accuracy of control provided by "heat acceleration."



The unit is equipped with a black setting wheel and winding knob on the same shaft for simple adjustment. The temperature setting can be made at any point as low as 45 F. The thermometer is recessed to guard against breakage. A

Last Call for SUMMER COOLING Still Time to SPECIFY AEROFIN Heat-Exchange Surface

The crucial period of the summer cooling season is here. When customers are in a hurry and everything is in a rush, performance counts. You cannot afford to take chances of failure in the heart of the cooling plant—the coil.

Play safe. Take advantage of the experience that has gone into the making of nearly 50,000,000 feet of heat exchange surface—the experience of expert technicians who have spent years in the study and development of cooling and heating coils. Order Aerofin today from one of the nearest Aerofin distributors, list of whom will be sent upon request.

Aerofin equipment consistently meets the most exacting demands of engineers, architects and contractors. It has been proven in thousands of installations. You can select your requirements from the most complete line on today's market.

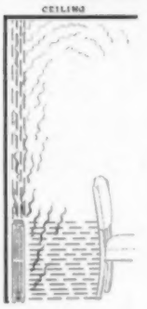
If you desire to know more about Aerofin, or need technical assistance in working out some problem, write today to the home office in Newark, or consult any of the branch offices listed below.

AEROFIN is sold only by Manufacturers of Nationally Advertised Fan System Apparatus. List upon Request

AEROFIN CORPORATION
850 FRELINGHUYSEN AVENUE
NEWARK, N. J.
Chicago · Detroit · New York · Philadelphia · Dallas · Atlanta

Prove It Yourself

Radiant heat travels in straight lines. Drafts do not deflect it. It does not heat the air it passes through. Does no heating until it strikes and is *reflected* from furniture, walls and persons. The test above proves that drafts have no effect on it. You feel just the same heat on your hand when the fan is running as when it is not.



Both Heats at Work

Burnham combines both radiant and convected heat in balanced proportions. Sketch shows you how radiant heat travels in straight lines, and convected in wavy circulatory ones. It is the balanced combination of them both in the Burnham Air Conditicning System of heating that makes it heat so much quicker and use less fuel.

Two Kinds of Heat From One Kind of Heating

THERE'S a lot of tall talking going the rounds these days about air conditioning heat, with the emphasis on radiant heat. And about as much loud lauding about the systems that have *only* convected heat.

Burnham's is neither or nor. It's BOTH. As much of one as the other. A balance between the two. Which is as it should be.

Either one by itself takes longer to heat. Too much of one, and not enough of the other, slows down the heating. Slowed down heating means two things: Delayed comfort and increased fuel consumption.

The Burnham Air Conditioning System is 100% radiator heating. Not part radiator and part hot air, with all the disadvantages of such systems, in extra room-taking basement equipment, ducts, grilles and all such.

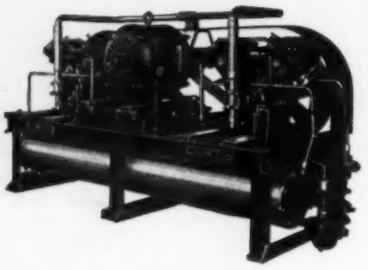
The Burnham does all that the other home air conditioning systems do, and *costs a lot less to do it*. Send for printed matter. Get the full facts. See for yourself.

Burnham Boiler Corporation
Irvington, New York Zanesville, Ohio
Representatives in All Principal Cities of the United States and Canada

Burnham Boiler

Performance Proves the Quality of

CURTIS CONDENSING UNITS



● Day after day, in thousands of air conditioning and refrigeration installations, the superior quality of Curtis design and construction is being proven beyond a doubt. Dependable, efficient, care-free performance is a characteristic of every one of the 86 Curtis Units, from 1/6 HP to 30 HP, air and water cooled.

Curtis quality is the result of 83 years of experience, of advanced engineering and precision manufacturing with 43 years specializing in building fine compressors.

Curtis engineering created the patented "Centro-Ring" method of positive pressure lubrication with no wearing parts. Curtis designing includes Timken Tapered Roller Main Bearings, water jacketed compressor heads and cylinders, drop forged heat-treated crankshafts and rods, balanced sylphon bellows seal, built-in oil separator with automatic return and automatic water valves, and precision manufacture throughout.

There's a Curtis condensing unit for every air conditioning and refrigeration need. Curtis quality guarantees superior performance.

CURTIS REFRIGERATING MACHINE CO.

Division of Curtis Manufacturing Company
1950 Kienlen Avenue, Saint Louis, Missouri

In Canada:
Canadian Curtis Refrigeration Company, Ltd.
20 George Street, Hamilton, Ontario, Canada

CURTIS

dial lock screw is furnished as standard equipment to prevent tampering with the temperature setting, and a locking device for the cover is available at no additional cost.

Furnished with a detachable wall plate for mounting and an adjustable differential; 55 to 85 F is the day scale range and 45 to 75 F is the night scale.—Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., South, Minneapolis, Minn.

Self-Contained Room Conditioner Developed

No. 1254—Designed to furnish summer comfort in single rooms without requiring a water connection, new unit room summer air conditioner has a built-in air cooled condensing unit. Air from outdoors is brought in through a window duct by a separate fan to cool the refrigerant in the condenser. After performing this function it absorbs the moisture condensed by the cooling coils and is discharged out the window.

The unit is semi-portable and has a cooling rating of about ⅔ of a ton; this can be increased to about 1 ton by supplying a small water line and making minor changes in the mechanism. No drain connection is required under either condition.

When the condenser is air cooled no water connection is needed and the cooling capacity is about 8000 Btu per hr. A slight increase in capacity is possible when there is considerable dehumidification from the cooling coils, because the condensate is pumped over the condenser coils at certain intervals, thus creating evaporative cooling in addition to air cooling.

When the condenser is cooled by evaporation, as it can be if desired, a small amount of water is continuously pumped over the condenser and the cooling capacity of the unit can be increased to about 11,000 Btu per hr. In this case a ¼ in. water line is connected to the unit.

The unit must necessarily be mounted at a window. It has a laminated window duct 18 in. in length which is adjustable to a shorter length. It is enclosed in a burled walnut cabinet with slotted moldings, through which air return and delivery passes. All controls are concealed.

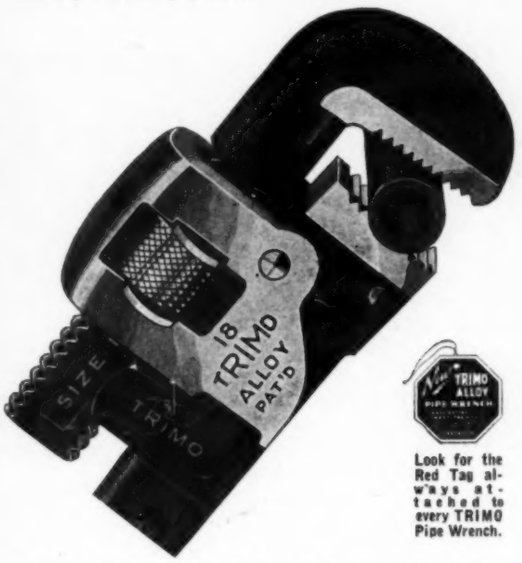
Operating cost of the unit is about 4c per hr., the maker states. The conditioner is approximately 41 in. long, 19 in. wide and 44½ in. high; with the cabinet it weighs about 550 lb.—General Electric Co., 1 River Rd., Schenectady, N. Y.

Electrode for Flat Welding Deep Groove Joints

No. 1255—A new arc welding electrode has been developed especially for flat welding of deep-groove joints in mild steel and to provide welds of new high quality in this type of work. Known as "Fleetweld 9," it will be welcomed, the maker feels, by industrial concerns engaged in the manufacture of products such as tanks, pressure vessels, etc., utilizing heavy plate construction and requiring production of high quality butt welds at maximum economy. Proper procedure with the electrode overcomes certain conditions frequently encountered in deep-groove welding which tend to cause the formation of surface holes in the metal, it is said.

JUST SAY TRIMO

When you are placing your order for pipe tools and intend to make sure of the best, just say "Trimo." This name stands for pipe tools of standard quality, known for dependability for fifty years.

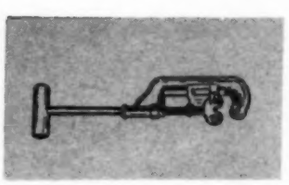


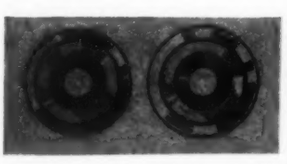
Look for the Red Tag always attached to every TRIMO Pipe Wrench.

Trimo Pipe Wrench: Made of Chrome Molybdenum Nickel Alloy Steel . . . Drop Forged . . . a hard gripping wrench with replaceable parts. Maximum strength, safety, economy.

Trimo Sawing Vise Set: Few investments today pay such a high return as this efficient unit. Trimo Sawing Vise Set pays for itself on its first job. It is the best thing on the market for holding, cutting and sizing thin wall copper tubing. Eliminates all waste of metal.

Trimo Tricrome Cutters: Made with the care and thoroughness that have marked Trimo production and inspection methods for half a century. Available in Trimo, Barnes and Saunders Types.





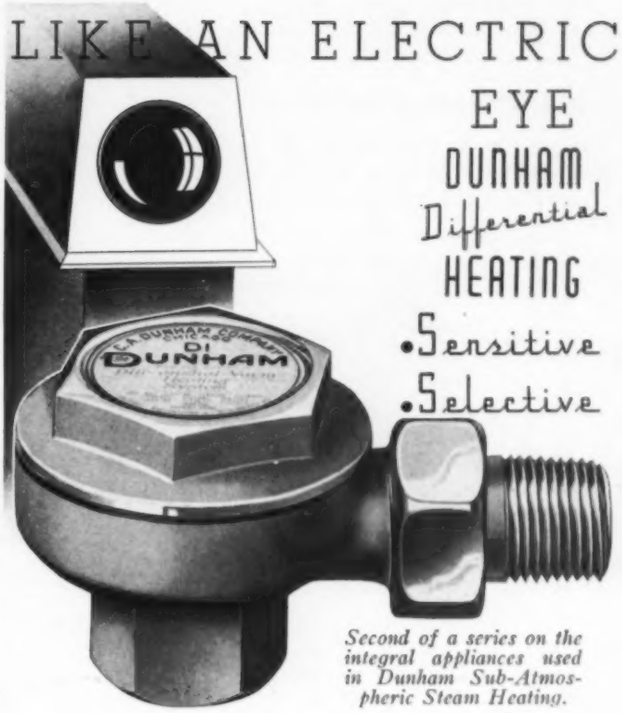
Tricrome Cutter Wheels: Made to fit all types of pipe cutters. Thin Blade Analysis Steel specially silvered to resist rust. Red hub always identifies Tricrome Cutter Wheels.

TRIMONT MFG. CO., INC.
ROXBURY (BOSTON), MASS.

LIKE AN ELECTRIC EYE

DUNHAM Differential HEATING

•Sensitive
•Selective



Second of a series on the integral appliances used in Dunham Sub-Atmospheric Steam Heating.

Dunham Differential Heating, like the "Electric Eye" is SENSITIVE and SELECTIVE. Sensitive to the varying heat demands of buildings — selective in its control of steam pressure, temperature and volume, to maintain constant indoor temperatures through every weather variation.

Differential Heating keeps good buildings comfortable. It distributes Sub-atmospheric Steam ("cool" steam) continuously, but at rates which vary imperceptibly with the need for heat. The uniquely low temperatures used (down to 133° F) account for the pleasant "feel" of Differential-heated buildings. Low radiator temperature warms the room air without scorching it and keeps that air in continual circulation.

The Dunham Thermostatic Trap is likewise sensitive and selective, for it is the perfected successor of the original trap which revolutionized low pressure steam heating over a third of a century ago. Designed and installed as *one of the integral parts which function with other coordinated appliances* to provide Differential Heating, it operates effectively over the more than 75° F range of steam temperatures used in Sub-atmospheric Steam Heating Systems.

Under certain conditions the values of this trap may be secured for other than Differential systems.

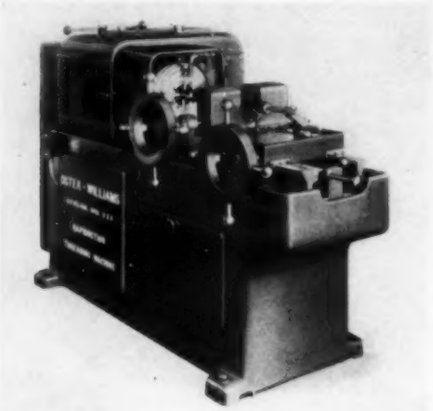
Consult the Architect for good design and the Consulting Engineer for mechanical equipment.

C. A. DUNHAM COMPANY
450 East Ohio Street **Chicago**

The electrode is designed to operate with either alternating or direct current, and is made in three sizes, 5/32, 1/4 and 5/16 in. —Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio.

Bolt Threading Machine Has New Features

No. 1256—Improved single spindle "Rapiduction" bolt threading machine is built for high production on standard runs in bolt plants and for increased production on an extremely wide variety of special work. Its regular bolt range covers all sizes from 3/8 to 1½ in. at spindle speeds ranging from 49 to 298 rpm.



The machine is of modern design. Timken bearings are used throughout and the die-head is made of hardened and ground tool steel. All the dies are of high speed steel. The spindle is made of high carbon steel forgings, heat treated and ground.

Semi-steel makes up the vise carriage, which is rigidly supported with both lateral and vertical adjustments for wear. Guards cover all moving parts of the machine that might cause injury.—Oster Mfg. Co., 2057 E. 61st Pl., Cleveland, Ohio.

Totally Enclosed Fan Cooled Motors Announced

No. 1257—Newly developed motor has been designed to meet the demand for a totally enclosed sealed unit for driving equipment which must be operated in atmospheres heavily laden with abrasive dusts, deteriorating metals and salts, explosive dusts, corrosive gases and extreme dampness on out-of-door applications.

This unit consists of a skeleton type stator, deeply grooved on the outside to increase radiation, which is provided with totally enclosed ball bearing endplates with long machined fits to seal the working parts of the unit. An external blower is mounted on the front end which directs cooling air around the front endplate and over the corrugated surfaces and through a baffled back endplate down over the bearing. The movement of the air is directed over those surfaces by specially designed blower and frame shields.

All coils are wound with cotton-covered double-enameled wire with all free ends taped well into the slots. All coils are insulated from core by heavy fiber slot insulating material.—Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.

NO FIRE HAZARD HERE!

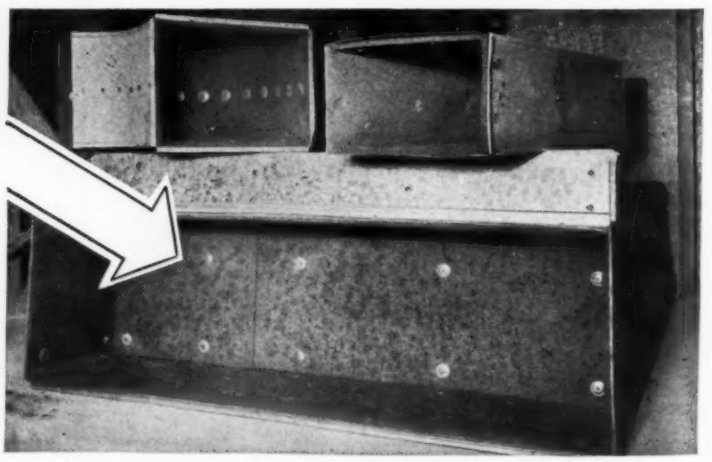
SERIOUS LOSSES have been reported in buildings where combustible sound absorbents—used to line air-conditioning ducts—have caught fire*.

The use of Johns-Manville Airacoustic Sheets for duct lining permanently eliminates this costly, unnecessary threat. Not only do these sheets provide as high as 80% sound absorption —but also, *they cannot burn or smolder. Can never contribute to fire spread.*

Furthermore, J-M Airacoustic Sheets are mineral in character . . . hence, permanent. Highly resistant to moisture . . . a serious enemy to the life of any material used in air-conditioning equipment. Light in weight, they are easily handled, quickly applied. Thermal conductivity is low; transverse strength high. And being smooth-surfaced—Airacoustic Sheets have a low frictional resistance.

For complete data on J-M Airacoustic Sheets, write Johns-Manville, 22 East 40th Street, New York City.

* In our files are bulletins from The National Board of Fire Underwriters, reporting several cases of this very nature.



JM Johns-Manville
AIR ACOUSTIC SHEETS FOR DUCT LINING

Get Genuine RIC-WIL Conduit!

Interlocking Construction

Stability

•

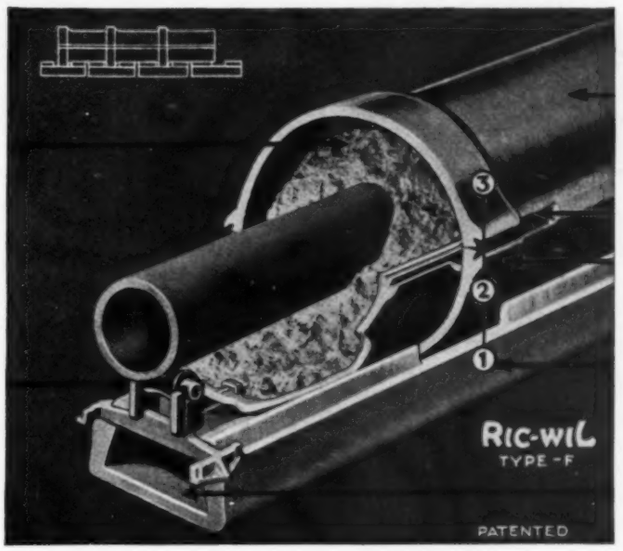
Famous RIC-WIL DRY-PAC Waterproof Asbestos Insulation

High Efficiency

•

Practical Supports for Pipes Snap in Place

Speed



Best Vitrified Glazed Tile

Everlasting Waterproof

•

Famous LOC-LIP Joint Continuous Visible

Practical

•

Old Reliable Bell Joint

Positive

•

Only Three Pieces to Handle for Two Feet of System - Only Three Joints

Low Cost

•

Base Drain Foundation Non-Settling Ample Drainage

Substantial

● They say imitation is the sincerest form of flattery! But it's not the best form of protection for your underground steam lines. Other systems may *look* like Ric-wiL—they may *sound* like Ric-wiL. But they don't SERVE like Ric-wiL. Careful analysis will reveal the basic differences between Ric-wiL and other systems. Many of our exclusive designs are covered by U. S. Patents. To be sure of genuine protection for your steam lines—you must be sure you get *genuine* Ric-wiL Conduit.

Write for catalog with Dry-paC sample for testing.

The Ric-wiL Co., Union Trust Bldg., Cleveland, Ohio
New York - San Francisco - Chicago
Agents in principal cities
REGISTERED IN U. S. PATENT OFFICE

RIC-WIL

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

THIS FILTER

on your Air Conditioning Equipment

MEANS

. . . BETTER SELLING POINTS

. . . GREATER CUSTOMER SATISFACTION

YOU CAN easily make your equipment more efficient . . . insure better results for your customers with Arco Air Filters. These filters are constructed with special 90° "V" angles that change air direction and scrub it clean. They take dirt and other foreign matter from the air and *keep* it. They hold more dust and last longer.

Arco Air Filters are light, odorless, inexpensive, and are furnished in sizes to fit any air conditioning unit. For complete details write to—

INDUSTRIAL DIVISION
AMERICAN RADIATOR COMPANY
DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION
40 West 40th Street, New York, N. Y.

ARCO Air FILTERS

● Cellular passages and 90° change in direction of air flow give Arco Air Filters their uniformity and efficiency.

Baltimore branch of the Federal Reserve Bank of Richmond, Baltimore, Md.

MODERNIZE HEATING IN FEDERAL RESERVE BANK

Baltimore Bank, Constructed in 1927, Improves Service with Webster Moderator System

DISTRICT STEAM SERVICE

Baltimore, Md.—That heating systems sometimes become obsolete before they become old was demonstrated in the five-story building which houses the Baltimore branch of the Federal Reserve Bank of Richmond.

When constructed in 1927, the Federal Reserve Bank building was modern in every detail. In 1936, only eight years later, the rapid developments in heating science made the application of Webster Central Control a necessary step in keeping the heating system up-to-date.

With the Webster Moderator System, steam is delivered continuously to all radiators without excessive heating, thus correcting the distribution weakness of the old installation.

The need for a central heating control responsive to outdoor weather conditions has been met by an Outdoor Thermostat, which adjusts the steam supply automatically with every change in weather or wind direction. A manual Variator permits the operator to modify the effect of the thermostat.

"The Webster Moderator System has enabled us to maintain uniform, adequate temperatures throughout the building," says F. W. Wrightson, Assistant Cashier.

"There has been a noticeable improvement in the cleanliness of our building since the introduction of district steam service. This means better heating service."

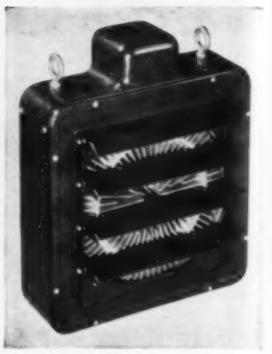
The Baltimore Heat Corporation acted as modernization heating contractors.

Use of district steam for heating was authorized because of its economy and dependability in combination with the Webster Moderator System.

If you are interested in heating *new* buildings, or in improved heating service and lower heating cost in your present building, address WARREN WEBSTER & CO., Camden, N. J. Pioneers of the Vacuum System of Steam Heating Representatives in 60 principal U.S. Cities—Est. 1888

WEBSTER MODERATOR CONTROL "Control by the weather"

Electric Heater for Plants

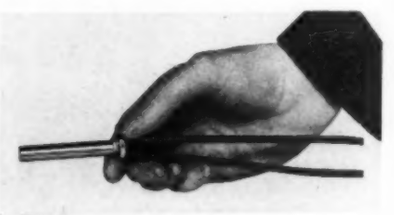


No. 1258—New "Electromode" industrial heater incorporates several features, including single, cast, circular grid; a cast aluminum fan housing; and a stronger housing construction. The heat source is a cast aluminum grid, which has been poured around a calrod heating element. A motor driven, four blade aluminum fan, running on a graphite impregnated bronze bushing for quiet operation, dissipates heat from the entire surface of the circular grid and circulates the warm air. Heat can be directed wherever it is needed by moving a series of adjustable deflectors mounted on the front of the unit. —Electric Air Heater Co., Div. of American Foundry Equipment Co., 555 S. Byrkit St., Mishawaka, Ind.

New Electric Heating Units Developed

No. 1259—Where a "spot" of heat is required within a limited space, a new small cartridge type heating unit offers many advantages. The unit is only ⅜ in. in diameter and is manufactured with brass sheath for maximum operating temperature of 750 F. It is especially convenient for built-in applications and can be quickly installed, the maker says, and is available in ratings of 30, 75, and 90 watts at 115 or 230 volts a-c or d-c.

Another new unit is a "strip" heater with offset terminals, which construction facilitates wiring and arrangement of strip heaters in series. The new units, which, except for their terminals, are



similar in construction to the manufacturer's standard strip heaters, are available in convenient lengths and ratings.

As a further aid to easy wiring, a busbar has been developed for use with the new heating unit. Holes punched in the busbar at frequent intervals fit the offset terminals and allow a wide choice of spacing of the heaters.—General Electric Co., 1 River Rd., Schenectady, N. Y.

New A-C Welder Completes Line

No. 1260—A 150-ampere a-c transformer type arc welder completes an extensive line so that there are now available units in capacities of 150, 300, 500, 750 and 1,000 amperes. All are complete and self-contained units and need no other accessories, except the welding cable, electrode holder and hand shield.

One of the features incorporated in the machine is a system of

Fast, Easy

PIPE CUTTING

With This Remarkable RIDGID Thin Tool Steel Cutter Blade

The secret of its unusual performance lies in the way the wheel blade is made. Coined from sheet tool steel, hammered, heat-treated and cast into a reinforced hub, this RIDGID blade has the stamina that makes it stand up through hundreds of extra pipe cuts, leaving practically no burr.

You'll like the RIDGID Cutter—
try one at your jobber's.

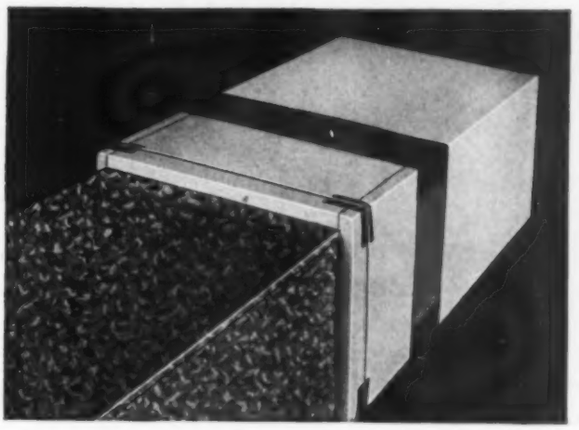
Housing of the RIDGID Cutter is steel reinforced, guaranteed not to break or warp. Makes the blades always cut true.

THE RIDGE TOOL CO., ELYRIA, OHIO

A Mate

The RIDGID Wrench with unconditionally guaranteed housing—that saves you fully 75% of your wrench repairs.

Modern AIR CONDITIONING



• • • Made More Modern With Careycel

CUTS HEAT LOSSES 30% OVER AIR-CELL TYPE

The cross-sectional illustration shows the smallness of air spaces in Careycel as compared with ordinary air-cell. This is the principal reason for its higher efficiency and is made possible by the exclusive Carey process of "cellizing" the asbestos sheets.

Careycel is the perfect insulation for air-conditioning ducts, having the essential qualities both to retain the warm air in winter and prevent costly loss of cold air in summer.

Tests at Mellon Institute proved heat losses through Careycel 30% less than through same thickness of air-cell . . . that Careycel is practically non-shrinkable . . . eliminates inefficient cracks and joints . . . makes a more finished installation. Notwithstanding its sensational superiority, Careycel sells in the same price range as air-cell.

For samples and details, write Dept. 25.

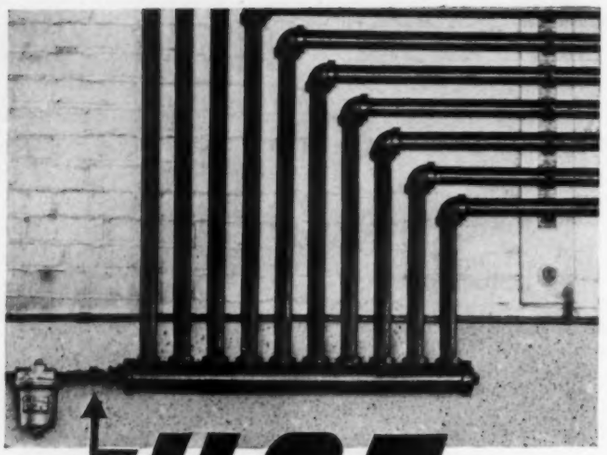
THE PHILIP CAREY COMPANY

Dependable Products Since 1873

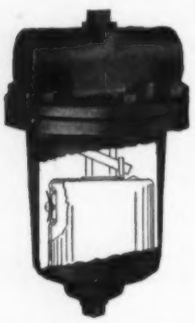
Lockland, Cincinnati, Ohio

BRANCHES IN PRINCIPAL CITIES

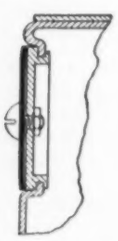
Careycel ASBESTOS INSULATION



HOT
50 MINUTES SOONER



Thermal Air Eliminator on the inverted bucket of the Anderson Super-Silvertop trap. Eliminator is in open position with disc curved away from the auxiliary air ports for quick removal of air.



Eliminator in the closed position with disc tightly covering the auxiliary ports.

WHEN AN ANDERSON Super-Silvertop steam trap equipped with snap action Thermal Air Eliminator was used, the above pipe coil became heated throughout its entire length in only four minutes. The inverted bucket trap previously used, required 54 minutes to heat the coil. In each case, steam entered the cold coil at five pounds pressure.

Fast heating requires fast air removal. Slow heating wastes time and is costly. This test shows the exceptional ability of the Thermal Air Eliminator to remove large volumes of air quickly, producing faster heat. The snap action thermal disc does not gradually close the auxiliary air ports as the temperature rises, but stays wide open discharging air until steam reaches the trap. Then the disc snaps shut.

Only Anderson Super-Silvertop traps can be equipped with the snap action Thermal Air Eliminator—another reason why we say Anderson Super-Silvertop is the only complete steam trap. Send for information about when and where quick air removal saves time and money.

THE V. D. ANDERSON COMPANY
1949 WEST 96TH STREET • CLEVELAND, OHIO

three controls or adjustments of the welding current. Through the medium of the first two controls it is possible to obtain 25 coarse adjustments. The third control offers a further and finer adjustment of current values within any one of the foregoing 25. By means of these three controls an infinite number of settings may be secured.—Wilson Welder and Metals Co., Inc., 60 E. 42nd St., New York, N. Y.

New Lever Motor Is Versatile

No. 1261—Improved pneumatically operated lever motor for the operation of dampers, lever operated valves, butterfly valves, or for the operation of any device by the conversion of pneumatic energy to linear or angular mechanical motion, is known as the "Motosteel Evenaction" lever motor. It is of all steel welded construction.

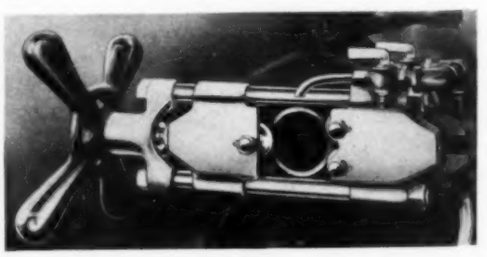
According to the maker, the precision operation characteristics insure a uniform relation between the air pressure applied to its diaphragm motor and the resulting lever travel throughout the stroke. It is said to be practically free of hysteresis.

A number of take-off holes are provided throughout the length of the lever so that the force or travel may be adjusted and the power of the up- or down-stroke may be increased or decreased by a spring adjusting nut.

It may be operated by remote manual control or by an electro-pneumatic switch or by a pneumatically operated controller.—Taylor Instrument Cos., 95 Ames St., Rochester, N. Y.

New Features for Portable Cutting and Threading Unit

No. 1262—A choice of wheel and roller cutoff or automatic knife cutoff to enable the user to select the type best adapted to his particular work has been announced as a feature of a portable machine for cutting and threading pipe and bolts. According to the maker, the knife cutoff is better for cutting soft electrical conduits and is necessary for scarfing pipe for welding



and for grooving pipe for "Victaulic" couplings. For all 'round work the wheel and roller cutoff is recommended because it is simple, fast and foolproof. The wheel type cutoff is illustrated here. The devices are interchangeable.

Among the mechanical features of the machine are the rack and pinion feed, quick opening and fully adjustable die heads, full ⅛ to 2 in. range, and "right hand" operation like a standard lathe or other machine tool.—Beaver Pipe Tools, Inc., 737 Keeney Ave., Warren, Ohio.

"It's our job! THANKS TO DEMING DEEP WELL TURBINES"

Where well water is available, a *dual service* can be performed by a Deming Deep Well Turbine Pump. It can provide a low cost water supply for air cooling equipment and reduce general water supply costs from 25% to 75%.

With the *dual service* advantages of Deming Turbine Pumps, you are in a stronger position to land air cooling contracts for many commercial and industrial installations otherwise difficult or impossible to obtain.

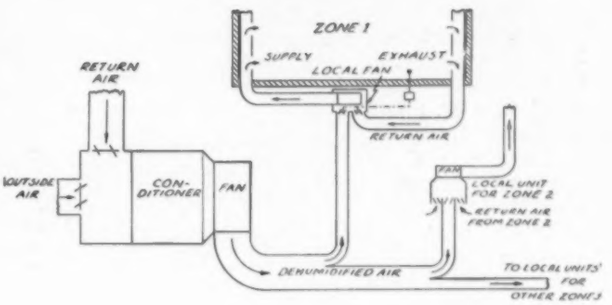
Deming Deep Well Turbines have many noteworthy features such as *water lubrication . . . adjustable impeller clearance . . . cutless rubber bearings . . . polished stainless steel bearing sleeves* . . . and many other advantages.

•Deming Deep Well Turbine Pumps are built to operate in wells of 5 5/8" and larger inside diameter and range in capacity from 25 to 2000 gals. per min. Write for Bulletin.

DEMING Pumps

THE DEMING CO. • SALEM, OHIO

FOR MODERNIZATION AND ZONED SYSTEMS



AUDITORIUM Conditioning Corporation presents this system (*) especially for those who wish to include air conditioning in their modernization programs and for those who desire to install an air conditioning system which can provide wide variations in air conditions in different parts of the same enclosure or building.

Intensively conditioned air is delivered from a central source to a number of units serving separate rooms or different parts of a single area. At each unit the cold air is augmented by room air under manual or automatic control so that air at different final temperatures may be delivered by the different units.

The system is economical as its operation is limited to active units. Sun effect and different degrees of occupancy are compensated for. It is of special value in hotels and offices where different people have different ideas of comfort.

Our licensees will gladly give you further information and tell you of many variations of this system for accommodating different conditions.

American Blower Corp.
Detroit, Mich.

Buffalo Forge Company
Buffalo, New York

Carrier Corporation
Newark, New Jersey

Frick Company
Waynesboro, Pa.

General Electric Company
Schenectady, N. Y.

J. O. Ross Engineering Corp.
New York, N. Y.

The Cooling & Air Conditioning Corp.
(Division of B. F. Sturtevant Co.)
Hyde Park, Boston, Mass.

Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

York Ice Machinery Corporation
York, Pa.

(*) Auditorium Air Conditioning Systems are covered by many issued patents and pending applications.

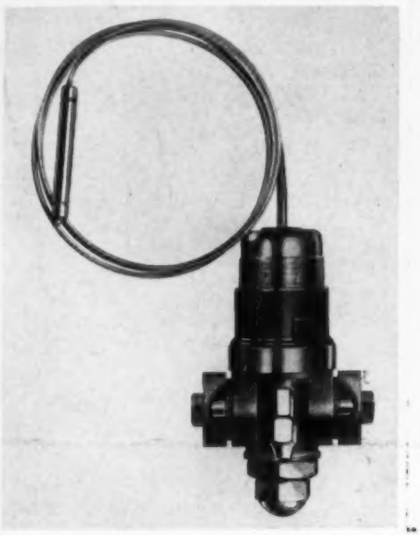
AUDITORIUM CONDITIONING CORPORATION

New York Office 17 East 42nd Street . New York

Improvement of Expansion Valves Told

No. 1263—Thermostatic expansion valves of one manufacturer, used on air conditioning and other types of refrigerating systems, have several new improvements.

Formerly, it was considered necessary to build a valve which could be easily disassembled, so that various parts which might be subject to failure could be easily replaced. It was found, however, that servicemen in the field were not equipped to repair expansion valves, and furthermore, they considered it advisable to return the valve to the factory. With this experience, a valve was designed with the idea of reducing service to a minimum and no attempt was made to arrange the parts for service in the field. At assembly all joints were soldered up so as to completely eliminate the possibility of leakage through gaskets.



With a valve sealed up at the factory it became necessary to improve materials to reduce failure to a minimum. In this connection corrosion of needles and seats, and failure of the flexible bellows had always presented a serious problem. New materials were developed for the needle and seat, and also a new type of bellows.

Another development is the gas charged power element and the ability of the valve to maintain a constant superheat. It was found that by making the power element bellows slightly smaller in diameter than the bellows in the body, that a constant superheat would be maintained regardless of the pressure of the system, which construction made it possible to adjust the valves at the factory to a standard superheat setting.

The gas charged power element was developed to limit the maximum pressure at which the valve could open or, in other words, to provide a cut off point which insured that the valve would be closed whenever the pressure in the system rose above a predetermined point. This acts as a safety feature to prevent overload on the motor especially when starting up a warm system or when abnormal conditions prevail.

Other features include a range of orifice sizes, interchangeable tail pipes, and strainers.—Detroit Lubricator Co., 5900 Trumbull Ave., Detroit, Mich.

Plane Conditioner Mounted on Truck

No. 1264—New airplane air conditioners for use at landing fields are entirely self contained and are mounted on Chevrolet or Ford high speed truck chassis.

The unit operates without external connections and has sufficient capacity to continuously heat or cool a five-room house or establish a 70 F temperature in a 21 passenger plane cabin in about 10 minutes elapsed time. An immediate shift from heating to cooling operation may be made.

The air conditioner has its own gasoline driven power supply, with a 15 kw generator supplying current for the electric motors. A blower fan drives air over the refrigerating machine cooling coils in which "Freon" gas is used. This cooled air passes into the cabin of the plane at the rate of 1200 cfm through a large hose.

REX-WELD "Super-Service"
VIBRATION ABSORBERS
for Air-Conditioning Machinery
● Here's the ideal solution to the compressor noise problem! Installed in the suction and discharge lines, these Rex-Weld Flexible Metal Tubing Units effectively dampen the vibration and put an end to the annoying hammering—surely, safely and economically . . . Produced by an exclusive patented process which forms the flexible tubing corrugations without weakening the special, non-porous, non-crystallizing bronze alloy. Supplied complete with capped ends ready for sweating onto standard water tubing. Write for Bulletin RW-4 and Data Sheet. Send us your specifications for prices.
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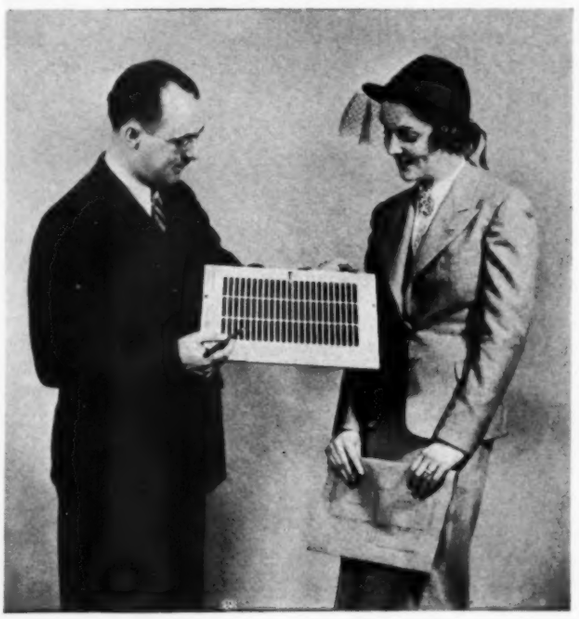
(Formerly Chicago Tubing and Braiding Company—Est. 1902)
Maywood, Illinois (Chicago Suburb)



Is She Modernizing Her Home?

If she is, you can please her by suggesting the *correct* registers. Home renovizing, especially of out-of-date heating systems, is increasing. Auer Registers, Intakes, and Grilles represent a complete line for both gravity and air conditioning systems. Give *your* customers the benefit of the modern efficiency and modern styling that have made AUER Registers so popular for remodeling as well as new construction. You will find the NEW AUER Register Book of real assistance in the selection of exactly the right registers for your work—ask for it.

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& GRILLES For Air Conditioning *and* Gravity

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FOR EVERY AIR CONDITIONING AND REFRIGERATION USE

• It can't leak...it can't break...it's stronger than the pipe itself. It's proof against vibration, strain and pressure. Arco Copper-to-Copper—non-porous, corrosion-resisting, and smooth inside, with Full Flow Fittings, to cut down friction loss. Get the story of Wrought Copper-to-Copper—standardize on Arco for equipment or replacement. Great variety of fittings available in sizes from ¼" to 4". Write for details to

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DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION
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IN ANY DIRECTION DESIRED
UP OR DOWN RIGHT OR LEFT

Grille bars can be set individually at pre-determined angles before installing; and after the system is operating, they can easily be changed to make any necessary corrections or to meet unforeseen or changed conditions.

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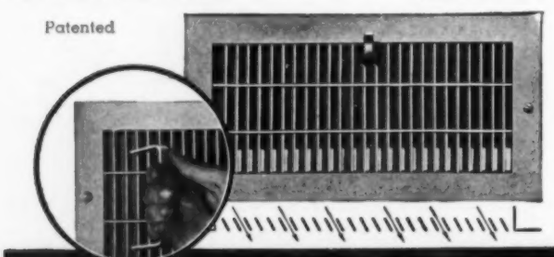
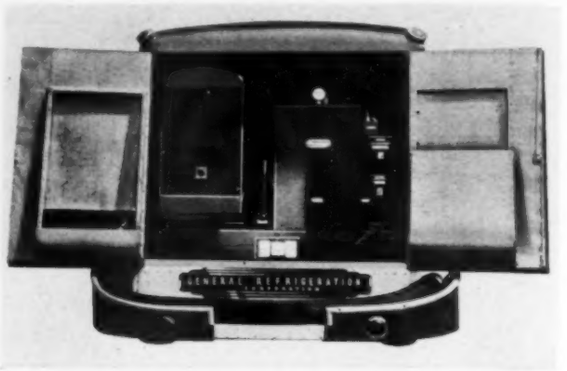


INDEPENDENT
"Fabrikated" adjustable
DIRECTED AIR FLOW
REGISTERS and GRILLES

For winter operation, jacket water from the gasoline engine is utilized in conjunction with the four electric grids to heat the air which is then blown through the hose to the plane.

The truck's body is streamlined, sound proofed, and ventilated, and its ducts are sound proofed, to reduce noise when it is



placed in operation outside the station. An interesting feature is the fact that it is in itself an auxiliary power plant, and in case of need can be used around a hangar for supplying power to the radio station or keeping the electric current and lights on.

American Airlines has placed 12 of the units in service.—General Refrigeration Corp., Beloit, Wis.

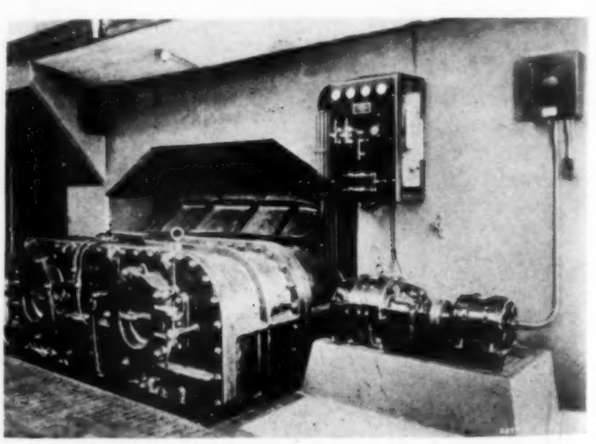
Combats Corrosion Electrolytically

No. 1265—A principal cause of corrosion is electro-chemical. Metals have a tendency to go into solution in water, displacing an equivalent amount of hydrogen, or metal. This tendency of metals to go into solution varies with different metals, and is furthermore affected by a number of other factors, such as temperature, acidity, and so forth. For all practical purposes, a vessel containing water may be regarded as a storage battery, with the water acting as the electrolyte.

The improved "Kirkaldy" system controls corrosion by confining it to bars of metal placed into the water for that purpose. The power plant units containing water still remain, in effect, a storage battery, or rather an electroplating tank but the polarity is reversed. Boilers, condensers, pumps, heaters, and pipe lines, having normally positive polarity, are made cathodic, or negative. At the positive pole, or anode, are the corrosible metal electrodes placed within the water and electrically insulated from the power plant units.

This reverse polarity is maintained by a weak direct current supplied by a motor generator and controlled at a small switchboard.

The system accomplishes more than corrosion prevention, the maker states. Scale and slime cannot adhere to the cathodic walls of the power plant equipment. Acid radicals, such as



Mundet Cork Insulation for Air Conditioning

Refrigeration Costs are

LOWERED . . . .

. . . when "Jointite"* Cork Insulation is used for low temperature requirements. Due to our method of selecting, grading and fabricating the pure Cork, you get Cork insulation at its maximum efficiency when you specify "Jointite."

"Jointite" insulating products include Corkboard (in the correct thicknesses for air conditioning service) and Moulded Cork Pipe Covering in standard lengths and thicknesses.

Our engineering department will be glad to cooperate with you in the preparation of specifications and estimates. Catalog sent on request.

Machinery vibration is permanently isolated with Mundet Natural Cork Mats. Ask for details.

*Trade Mark Reg. U. S. Pat. Off.

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No cutting - No threading - No fitting of the main pipe with WeldOlets and ThredOlets

Pipe-to-pipe intersection welds are not satisfactory in piping installations. Only WeldOlets and ThredOlets provide a junction of full pipe strength. Due to their funnel-shaped outlets, turbulence and friction are reduced to minimum.

No cutting, threading or fitting of the main pipe is necessary to install them. No templets are used. The fitting is welded in place at the point selected for the outlet and the hole is cut after welding. A leak-proof joint is obtained and a neat, workmanlike job is the result.

Mail the coupon below for Bulletin WT21 giving full details.

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Please send me copy of Bulletin WT21 and name of nearest distributor of WeldOlets and ThredOlets.

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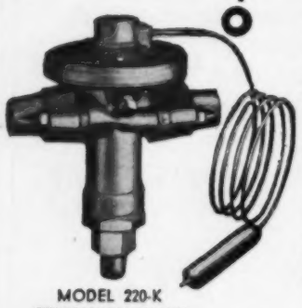

MODEL 220-K EXPANSION VALVE

Thermostatic Expansion Valves . . . . . .

Through every step in the making of A-P Thermostatic Expansion Valves, from critical inspection of raw materials to checking every part of the assembly, precautions are taken to assure a perfect control unit. These precautions are climaxed with a triple test of the completed assembly, to eliminate every possible cause for service failure. Such thorough testing assures you of dependability and makes your selling job easier.

A-P Thermostatic Expansion Valves are available up to 15 tons freon capacity.

PROGRESSIVE JOBBERS EVERYWHERE STOCK AP CONTROLS.

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2460 NORTH THIRTY-SECOND STREET
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AIR CONDITIONING NOZZLES

Nozzles of unique Yarway Involute Design.

No internal parts or vanes to clog or erode.

Insure trouble-free air washing service.

Sizes and types for all requirements.

Many large users—installations total more than 5 million gallons per minute in water cooling and air conditioning service. Write for Bulletin N-615.

YARNALL-WARING COMPANY
MERMAID AND ANDERSON STS.
PHILADELPHIA

YARWAY

carbonate, sulphate and silica, which are necessary in building up the scale, are electrically carried to the anodes, and away from the power plant unit surfaces. If scale is already present when the installation is made, the thin film of liberated hydrogen, now being formed on the cathodic walls of the power plant units, will gradually loosen the scale and then remove it altogether. Particles of slime and vegetable matter cannot gain a foothold on the cathodic walls of the power plant units, as they are repelled electrically, just as a pith ball is repelled by a charged stick of sealing wax. The illustration shows an application on a condenser.

The installation consists of a number of suitable anodic bars or discs (mild steel or carbon) mounted within but electrically insulated from the power plant units; an electric motor-generator; an automatic current controller; a control switchboard; and necessary wiring to complete the circuit. The operating norms are calculated on the basis of total power plant surface to be protected, anodic surface available, anode material, chemical composition and electrical conductivity of the water, and other factors; and after the current controller is adjusted to the determined values, the operation is automatic.

The voltage required is from 5 to 10 volts, depending on conditions, and current consumption is stated to be from 0.4 kw hr per day per 1000 sq ft of protected surface with salt water, to 2.0 kw hr per day per 1000 sq ft with fresh water.—Electrolytic Metal Protection, Inc., 247 Park Ave., New York, N. Y.

Screw Drivers Fit Phillips Screws

No. 1266—Four sizes of screw drivers to fit Phillips screws (which are used increasingly in industrial and automotive work) have been added to an extensive line. The blades are drop forged from selected steel and heat treated. They are firmly anchored in hardwood handles which are fluted to provide a firm grip.—Bonney Forge & Tool Wks., Tilghman St. & Meadow St., Allentown, Pa.

Underground Piping for Oil and Gasoline

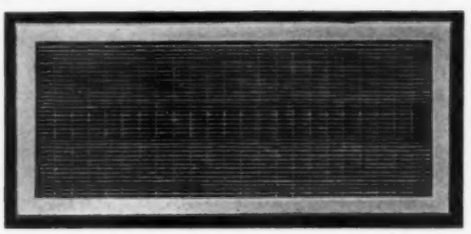
"I WOULD like to get some information on oil and gasoline piping that is to be buried in the ground. Is galvanized wrought iron pipe suitable?" asks a reader of H. P. & A. C.

In answer to this question, it is my experience that there is little purpose served in using galvanized pipe underground for such service. It is true that a galvanized surface will resist corrosion much better than an unprotected surface, but when galvanized pipe is threaded the zinc is removed from the threaded portion, and when the pipe is screwed up, that portion of the thread remaining outside the fitting has no covering. As that point happens to be the weakest, for much of the metal has been removed and the wall thickness reduced, corrosion will occur there, offsetting the advantage gained by protection of the thickest wall surfaces. If the threaded areas protruding from the fitting be painted with some kind of tough covering, such as bitumastic paint, then the ultimate life of the piping may be prolonged.

For most soils, ordinary black steel pipe serves very well as buried pipe. Where corrosive conditions exist, wrought iron pipe will exhibit better resistive properties due to the slag inclusions inside the metal. If the pres-

WATERLOO

AirMaster GRILLES



A notable scientific advance in accurate, controlled diffusion or direction of incoming air—and a new conception of beauty in modern grilles. Multi-way diffusion, perfectly regulated through fine horizontal fins set at desired angles, and vertical back-louvers adjustable for lateral spread of air or vice versa. No raw edges exposed to air flow. Wider range of control. Full details sent upon request.

Waterloo Register Co.

Waterloo, Iowa—Seattle, Wash.
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Modernize with American-Marsh PUMPS

HOW LONG SINCE you checked the power requirements of your present pumps? Perhaps they cost more to keep than to replace with modern, highly-efficient American-Marsh Pumps, which may SAVE enough to pay for themselves in a year or two. Send for Bulletins.

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BATTLE CREEK, MICHIGAN . . . Pumps and Pumps Only Since 1873

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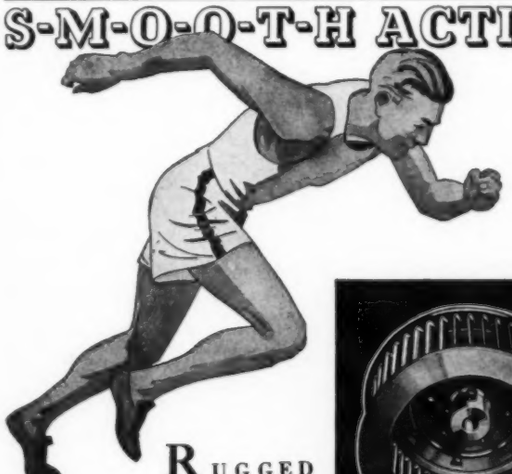
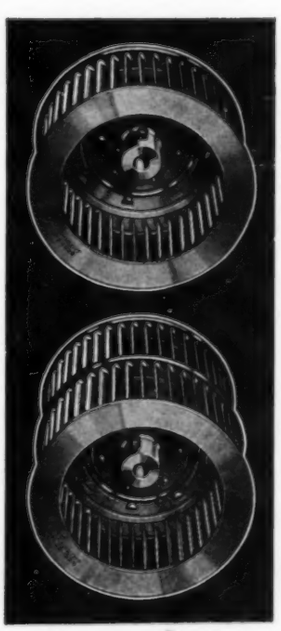


RUGGED strength with no surplus weight, quick easy starting, perfect balance, plus sound engineering born of experience — these are the reasons why TORRINGTON Blower Wheels are out in front! It will pay you to learn more about TORRINGTON'S complete line of Blower Wheels. Write for catalog with ratings for all sizes of wheels and table of dimensions for housing scroll design.

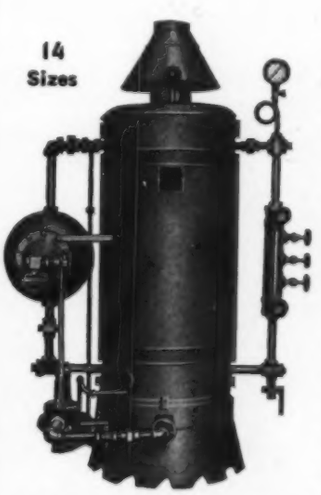


TORRINGTON MFG. CO. TORRINGTON, CONN. U. S. A.
TORRINGTON FANS AND BLOWER WHEELS

The Fastest Steam Boiler Made —

$AVES WHERE STEAM IS USED INTERMITTENTLY

14 Sizes



Steam in 4 minutes Ofeldt

Where steam is used only intermittently or for short periods, the OFELDT is invaluable . . . for it is the fastest steaming boiler on the market, generating steam 4 minutes after lighting.

Gas fired, it eliminates time-stealing firing and fuel and ash handling . . . automatically supplies plenty of Clean Steam under unvarying pressure, with the very minimum manual attention.

Specifications and prices upon request. No obligation.

• *For an inexpensive, small (1 to 5 H. P.), unjacketed steam boiler, there's the MKAYO. Ask about it, too.*

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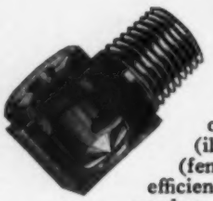
MONARCH
non-clogging
SPRAY NOZZLES



For Air Washing

We recommend either ¼" or ⅜" Fig. 629 male pipe (illustrated) or ¼" Fig. 631 (female) Brass nozzles. Small, efficient, and inexpensive, they produce an evenly distributed hollow cone spray. One large lead hole minimizes any clogging tendency. Capacities from 4.7 G.P.H. up. Now being used by some of the largest air conditioning manufacturers.

For Re-Cooling

Monarch Fig. B-8 and B-8-A cast Brass nozzles, for cooling condensing water in spray ponds, use no internal vanes or deflectors which might facilitate clogging. Available in capacities up to 104 G.P.M. at 10 lbs.

Write for New Catalog 6-A

MONARCH MFG. WORKS, INC.
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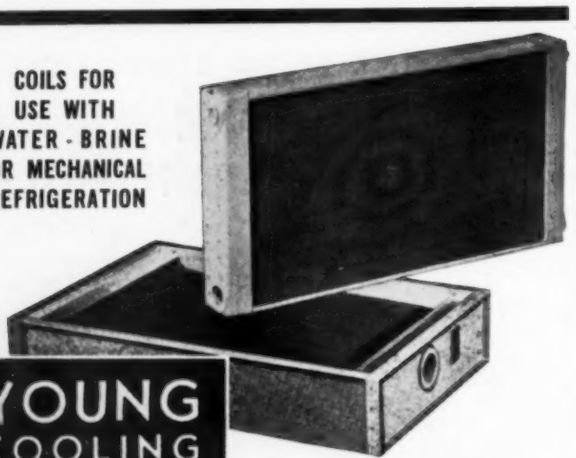
COILS FOR USE WITH WATER - BRINE OR MECHANICAL REFRIGERATION



YOUNG COOLING EQUIPMENT

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The YOUNG line of cooling surfaces is complete and well graduated in cooling capacities. Thus architects and contractors may select a unit to meet their most exacting specifications. All YOUNG cooling surfaces are scientifically designed and thoroughly tested to do a definite cooling job. For complete engineering information—write for literature.

Offices in All Principal Cities

YOUNG RADIATOR COMPANY
RACINE, WISCONSIN
Young Quality

ence of specially corrosive materials in a soil, such as industrial acid waste, makes pipe fail rapidly, then a solution of the problem is to coat the pipe with tar and wrap it in burlap. Galvanizing of pipe adds about 25 per cent to the cost and is usually not justifiable for underground service except for water lines, where the purpose is to prevent rusting of the inside of the pipe.

It must also be remembered that the tank to which the pipe connects is subject to soil conditions. A cinder back-fill should not be used over tank and pipe, as cinders impart an acid character to any water falling through. If underground waters are known to be acid in reaction, then the tank should be protected by a sprinkling of lime before back-filling.

To summarize, use black steel pipe for ordinary conditions of underground gasoline and oil lines. With slightly corrosive soil conditions, use cast iron pipe. In certain bad soils, genuine black wrought iron pipe will be best. When industrial acid wastes are known to be present, use tarred and wrapped black steel pipe. Do not bury tanks or pipe in cinders.—KALMAN STEINER.*

*Ace Engineering Co., Chicago, Ill.

The Editor's Page—

[*Continued from p. 45, front section*]

it was found to cost 1.01 cents per funeral to operate. . . . The duct work is a feature of the air conditioning in the Konner's men's clothing store, Paterson, N. J., says the Carrier Corp., whose equipment is used. The duct work appears to be a continuation of the mahogany clothing cases upon which it rests, the effect being achieved by enclosing the ducts in the same style paneling as that covering the display racks.

■ **The Industrial Unit Heater** Association is to meet at the Hotel Cleveland, Cleveland, Ohio, July 15, to consider the report of the engineering committee covering the standardization of unit heaters. . . . It is hoped that the adoption of a program of simplified practices will benefit both the buying public and the manufacturers. . . . Millions of dollars will be spent on air conditioning American hospitals during the next few years, J. K. Knighton, Nash-Kelvinator's manager of commercial air conditioning, predicts. . . . More than 300 hospitals are already making use of air conditioning, says Mr. Knighton, and the most popular places for installations have been in operating rooms, nurseries for premature and normal babies, in oxygen therapy and heat therapy rooms or cabinets, and allergic wards. . . . From the largest group of applicants ever received, 25 graduate engineers have been selected by the Trane Co. to participate in their annual training course, which continues for six months. . . . The appointment of Warner S. Hays as managing director of the American Welding Society has been announced.

■ **Richardson and Boynton** Co. announced last month that it has employed William Iselin & Co., factors, to handle their credits and collections. This is believed to mark the first instance of the use of factoring in the heating trade. . . . Factoring is said to date back in this country to 1808. . . . In a two day celebration attended by more than 3,000 persons, 14 companies of the American Radiator and Standard Sanitary Corp. opened the largest showroom in the building industry, a six story annex to the headquarters building in

HOFFMAN SPECIALTIES

The most complete line of heating specialties for every type of steam system

VENTING VALVES
TRAPS
SUPPLY VALVES
PUMPS

See your wholesaler or write to:
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WATERBURY, CONN.

SEATS GROUND TO A FULL BALL JOINT

THAT'S WHY DARTS *Sit Tight*

One look inside a Dart will show you why Darts keep union cost down to rock bottom. Two bronze seats are ground to a spherically-accurate, perfect fit on special oscillating grinders. Wide, full-bearing surfaces won't leak because they fit right—sit tight.

Furthermore, extra-heavy iron bodies resist stretch and distortion—withstand *repeated* use as often as required. Give a Dart a try. Let us send you one to test.

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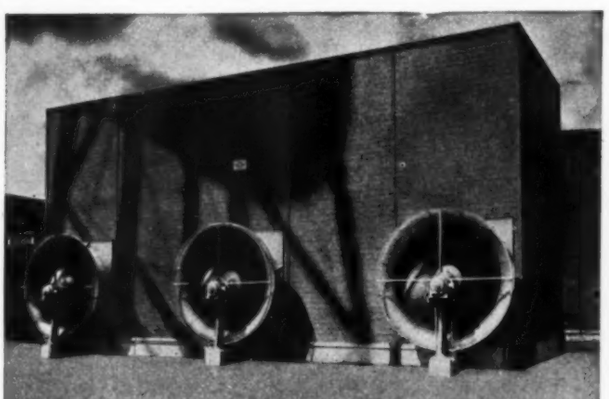

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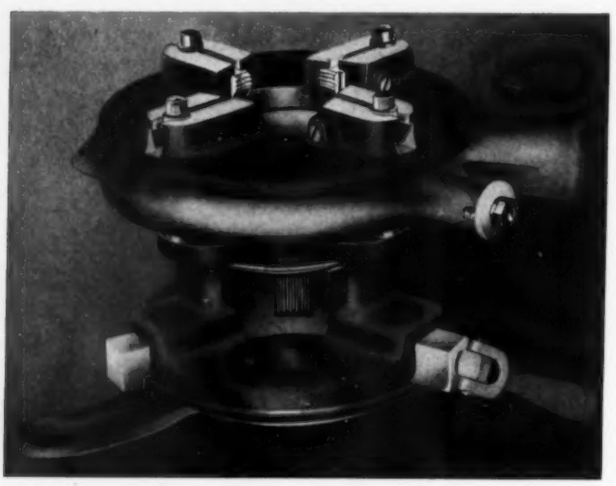

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Schools and Study Courses

New Head for Oil Burner Courses

The Herkimer Institute, 1819 Broadway, New York, N. Y., has announced that John W. Schulz is now in charge of its classes in oil heating and burners. He continues as technical adviser for several oil companies and manufacturers of oil burner equipment.

The courses are designed for those who wish to become service and installation experts. They consist of shop and laboratory work and lectures, and personal attendance by the student at the lecture rooms and shops is required. The school is open throughout the year and the student may start at any time.

Conventions and Expositions

Universal Craftsmen Council of Engineers of the World: Power show and mechanical exposition, August 3-7, Hotel Stevens, Chicago, Ill. General Chairman, W. T. Walters, 7965 Phillips Ave., Chicago, Ill.

National Association of Power Engineers: Convention, August 30-September 3, Jefferson Hotel, St. Louis, Mo.

American Gas Association: Annual convention, September 27-October 1, Hotel Cleveland, Cleveland, Ohio. Headquarters Office, 420 Lexington Ave., New York, N. Y.

Association of Iron and Steel Engineers: Convention and exposition, September 28-October 1, Hotel Stevens, Chicago, Ill. Headquarters Office, Empire Bldg., Pittsburgh, Pa.

Chicago Exposition of Power and Mechanical Engineering: October 4-9, International Amphitheatre, Chicago, Ill. Under management of the International Exposition Co., Grand Central Palace, New York, N. Y., manager of the biennial National Expositions of Power and Mechanical Engineering, the next of which will be held in New York City December 5-10, 1938.

American Public Health Association: Annual meeting, October 5-8, Hotel Pennsylvania, New York, N. Y. Headquarters Office, 450 7th Ave., New York, N. Y.

American Welding Society: Annual convention, week of October 18, Hotel Traymore, Atlantic City, N. J. Headquarters Office, 33 W. 39th St., New York, N. Y.

Metal and Welding Exposition: Week of October 18, Convention Hall, Atlantic City, N. J. American Society for Metals, 7016 Euclid Ave., Cleveland, Ohio.

American Petroleum Institute: Annual meeting, November 9-12, Hotel Stevens, Chicago, Ill. Headquarters Office, 50 W. 50th St., New York, N. Y.

Chemical Industries Exposition: December 6-11, Grand Central Palace, New York, N. Y.

Fifth International Heating and Ventilating Exposition: January 24-28, 1938, Grand Central Palace, New York, N. Y. Manager, Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y.

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Total Volume of Air	—9000 c. f. m.
Number of Anemostats	—3
Each Anemostat Distributes	—3000 c. f. m.

The ceiling is divided into three sections, the center of each section is vaulted and an Anemostat—outside diameter 61¾″—is set into the center of the vaulted part flush with the ceiling. A vertical ring is affixed to the outer cone, hiding light members and reflectors which throw the light into the vaulted part, resulting in a fine and unusual indirect lighting effect.

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Book Reviews

The Patient and the Weather

"The Patient and the Weather—Volume 4, Part 1, Organic Disease," by William F. Petersen, M. D., Professor of Pathology, College of Medicine, University of Illinois. Photolithographed. 663 + xxxiv pp., 8½x11 in., clot'bound. Published by Edwards Brothers, Inc., Ann Arbor, Mich. Price, $10.00.

Earlier volumes of Dr. Petersen's extensive work have previously been reviewed in HEATING, PIPING AND AIR CONDITIONING because it is thought that the author's discussion of how weather affects humans should be of more than passing interest to air conditioning engineers. If air conditioning is to become of increasing usefulness in the treatment of diseases and in its other "health" aspects—and there are many who feel that in coming years this phase of air conditioning will be its most important—it is necessary that the air conditioning industry be informed of the medical profession's work, and *vice versa.*

Dr. Petersen's lengthy preface to the present volume is most interesting—even to the layman. In it he describes the two major concepts he has previously treated, the second of which is that the meteorological (or weather) environment is the most potent factor to which adjustment must be made by the individual, and that this accommodation causes energy expenditure. It influences every disease just as it influences every physiological process, and while it is but one of several factors, he believes it is the most important of the common ones in our latitude.

His demonstration brings us, he points out, to the obvious corollary to which Hippocrates called attention; namely, that the "constitution" of the winter resolves the diseases of the summer and that the "constitution" of the summer resolves the diseases of the winter. In other words, "if we properly buffer our subjects in the winter and spring we will prevent or improve the pathological conditions of the period."

The first chapter deals with a wide variety of case histories, which have been taken at random from the recent literature. In each instance, the suggestive rôle of the weather as the precipitating factor is illustrated. Although this volume is "heavy going" for one unfamiliar with medical terms, a reading of some of these examples gives convincing support to Dr. Petersen's views on the importance of environment on health.

Engineering Thermodynamics

"Engineering Thermodynamics", by Newton C. Ebaugh, Head, Mechanical Engineering Department, University of Florida. 1st ed. 1937. *199 + x pp. and several large charts. 6 x 9 in., cloth-bound. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y. Price,* $2.85.

Arranged primarily as a textbook for students who have studied inorganic chemistry, general physics, and mathematics through calculus, this new volume presents the elementary essentials of the science of thermodynamics as applied to industrial equipment and processes. It has been arranged for flexibility in adapting it to different interests, and includes numerous examples, the answers for which are given in the appendix.

There are chapters on thermodynamics and energy, state of a fluid and changes of state, energy equations, gas properties and processes, cycles and available energy, entropy, vapor properties and processes, gas mixtures and gas and vapor mixtures, flow of fluids, vapor power cycles, internal combustion cycles, gas compression and refrigeration cycles. The appendix includes steam tables, Mollier charts for steam and for ammonia, and a psychrometric chart.

An understanding of thermodynamic principles being essential to the air conditioning engineer, the student of the art will find a review of the fundamentals as given in a work of this kind a necessity.

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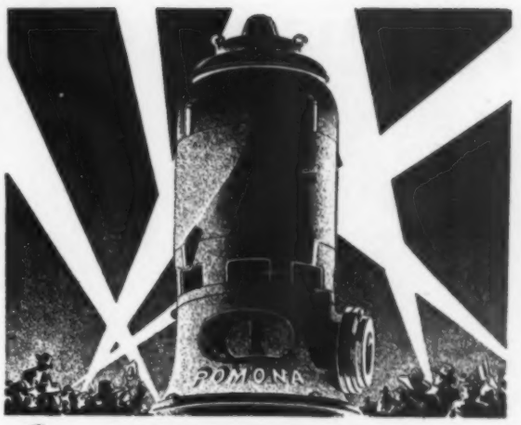

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Wired heat saves money!
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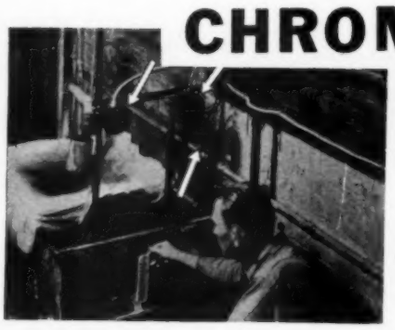

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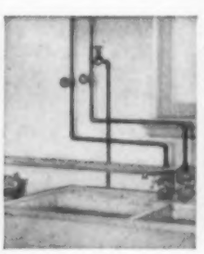
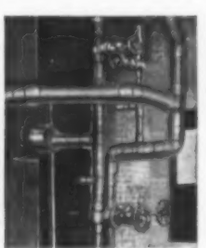

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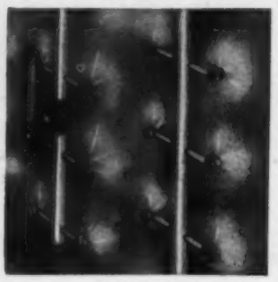

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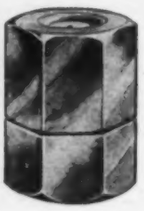

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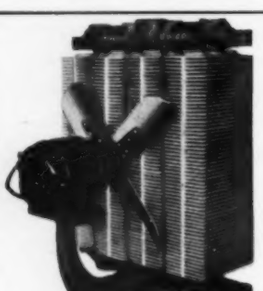

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Recent Trade Literature

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No. 2433. AIR CONDITIONING: Frick Co., Waynesboro, Pa. 24 p. bulletin listing representative installations of this company's refrigeration equipment for air conditioning theaters, hotels, restaurants, stores, hospitals, offices and industrial plants, giving name and location of the jobs, number and capacity of refrigerating machines, and the refrigerant used.

No. 2434. AIR CONDITIONING: Trane Co., La Crosse, Wis. Issue of "Weather Magic," Vol. 1, No. 2, including information on air conditioning a hotel, an office building, individual weather control in an apartment building, an example of savings with evaporative condensers, and other data.

No. 2435. AIR CONDITIONING: Westinghouse Electric & Mfg. Co., Mansfield, O. New data sheets for engineering data book, covering dimensions for spring mountings, condensing units, performance data for various types of condensing units and evaporative condensers, motor data, and descriptive literature on condensing units, air conditioning units and evaporative condensers.

No. 2436. AIR ELIMINATORS: Gorton Heating Corp., Cranford, N. J. 4 p. bulletin describing high pressure air eliminators for automatically venting driers, steam coils, and traps, under pressures up to 150 lb.

No. 2437. ALLOYS: Revere Copper and Brass, Inc., 230 Park Ave., New York, N. Y. Data sheet giving the chemical and physical properties of "Revere" alloys and condensing a great deal of helpful information about them.

No. 2438. CIRCULATORS: Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., S., Minneapolis, Minn. 4 p. bulletin describing the features of "Packless Seal" hot water heating circulators and relay.

No. 2439. CIRCULATORS: Motor Service & Mfg. Co., 3300 Indiana Ave., Chicago, Ill. Data sheet describing "Roto-Beam" air circulators.

No. 2440. COILS: Fedders Mfg. Co., 57 Tonawanda St., Buffalo, N. Y. Issue of "Fedders News," Vol. 4, No. 6, including an article on the difference between coils for summer and winter conditioning of air, giving sample calculations for a restaurant job.

No. 2441. EVAPORATIVE CONDENSERS: Frick Co., Waynesboro, Pa. 4 p. bulletin on evaporative condensers for ammonia and "Freon-12" refrigerating systems with description of features and specifications, and application information.

No. 2442. FANS: Torrington Mfg. Co., 70 Franklin St., Torrington, Conn. Two 4 p. bulletins, one on the "Standard" model and one on the "De Luxe" model "Airistocrat" air impellers, with dimension drawings, air delivery curves, and power consumption graphs.

No. 2443. INSULATION: Armstrong Cork Products Co., 994 Concord St., Lancaster, Pa. Handy reference card giving detailed information for pipe fitters and foremen on the proper spacing of cork covered pipe lines and instructions on hanging pipe; also of aid to those planning refrigeration lines. Also, a leaflet on cutting cold line losses with cork insulation.

No. 2444. LUBRICATION: E. F. Houghton & Co. 240 W. Somerset St., Philadelphia, Pa. Edition of "Research Illustrated" including information on plant surveys, bearing metals and lubrication, modern "V" packings, shop problems, and remedies with packings, belting, lubrication, etc.

No. 2445. MOTORS: Century Electric Co., 1806 Pine St., St. Louis, Mo. 8 p. bulletin on direct current motors of 1 to

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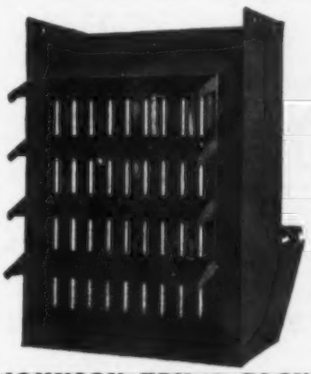

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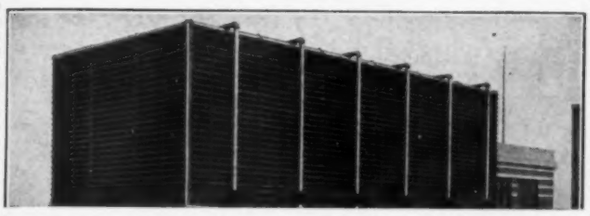

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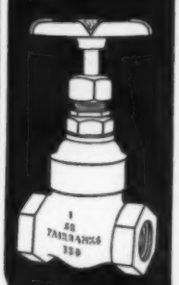

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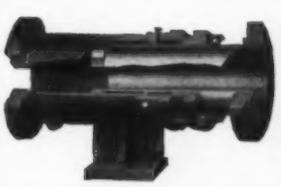

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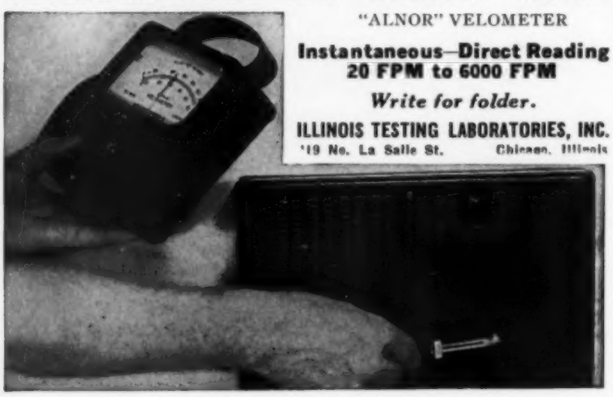

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1252	1253	1254	1255	1256	1257	1258
1259	1260	1261	1262	1263	1264	1265
1266						
2433	2434	2435	2436	2437	2438	2439
2440	2441	2442	2443	2444	2445	2446
2447	2448	2449	2450	2451	2452	2453
2454						

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Company .....

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300 hp, describing and illustrating features of construction. Also, an 8 p. bulletin on slip ring motors of 1 to 350 hp with detailed description of features.

No. 2446. MOTOR AND MAINTENANCE EQUIPMENT: Ideal Commutator Dresser Co., 1096 Park Ave., Sycamore, Ill. 76 p. catalog of motor and other maintenance equipment and electrical specialties giving a complete listing of the company's products and helpful data on electrical and motor maintenance work. A number of new items are included.

No. 2447. PURGERS: Frick Co., Waynesboro, Pa. 4 p. bulletin describing new purger for refrigerating systems using either ammonia or "Freon-12," describing how it saves horsepower and its installation and operation.

No. 2448. RADIATORS: American Radiator Co., 40 W. 40th St., New York, N. Y. 4 p. bulletin on "Arco" radiators with rating and dimension tables and drawings.

No. 2449. ROOM COOLERS: Nash-Kelvinator Corp., 14250 Plymouth Rd., Detroit, Mich. 4 p. data sheet on room cooling units, air cooled self-contained series, describing constructional and performance features and giving specifications and dimensions. Also, a folder on the advantages of these units.

No. 2450. SHIMS: Laminated Shim Co., Inc., 21-24 44th Ave., Long Island City, N. Y. 16 p. catalog on precision adjustment shims with detailed descriptions of the various types and information and illustrations of their uses.

No. 2451. STEAM TRAPS: W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa. 6 p. bulletin on industrial steam traps showing sectional illustrations of four types and recommended piping diagrams. Features of construction are carefully described.

No. 2452. STOKERS: Iron Fireman Mfg. Co., 3170 W. 106th St., Cleveland, Ohio. 16 p. catalog on commercial heating stokers with a discussion of their advantages and construction, including fuel control, fuel conveying, carburetion, combustion efficiency. Control data on proper installation is included.

No. 2453. UNIONS: Rockwood Sprinkler Co., of Mass., 38 Harlow St., Worcester, Mass. Folder on the new "Dualsteel" union for special uses describing its manufacture and features and indicating its various applications in different industries.

No. 2454. WELDED DESIGN: Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio. Revised engineering drafting room chart on arc welded design providing in ready reference form, data necessary for producing such designs. A feature is the latest welding symbols adopted by the American Welding Society. The chart is 24 x 35½ in., and is fitted with metal strips across the top and bottom, and a clip for hanging on the wall.